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Space Administration
Langley Research Center

Scientific and Technical
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NASA STI Program ... in Profile

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Introduction

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STAR includes citations to Research & Development (R&D) results reported in:

- NASA, NASA contractor, and NASA grantee reports
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- Other U.S. Government agency and foreign patents and patent applications
- Domestic and foreign dissertations and theses

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NASA Center for AeroSpace Information (CASI)

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The National Technical Information Service serves the American public as a central resource for unlimited, unclassified U.S. Government scientific, technical, engineering, and business related information. For more than 50 years NTIS has provided businesses, universities, and the public timely access to well over 2 million publications covering over 350 subject areas. Visit NTIS at http://www.ntis.gov.

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The U.S. Congress established the **Federal Depository Library Program** (FDLP) to ensure access by the American public to U.S. Government information. The program acquires and disseminates information products from all three branches of the U.S. Government to nearly 1,300 Federal depository libraries nationwide. The libraries maintain these information products as part of their existing collections and are responsible for assuring that the public has free access to the information. Locate the Federal Depository Libraries http://www.access.gpo.gov/su_docs.

The U.S. Patent and Trademark Office (USPTO)

The U.S. Patent and Trademark Office provides online access to full text patents and patent applications. The database includes patents back to 1976 plus some pre-1975 patents. Visit the USPTO at http://www.uspto.gov/patft/.

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Subject Term Index

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SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS

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01
AERONAUTICS (GENERAL)

Includes general research topics related to manned and unmanned aircraft and the problems of flight within the Earth's atmosphere. Also includes manufacturing, maintenance, and repair of aircraft. For specific topics in aeronautics, see *categories 02 through 09*. For information related to space vehicles *see 12 Astronautics*.

20030060633 NASA Langley Research Center, Hampton, VA, USA

Non-Continuum Hypersonic Shock Interactions on a Simulated Airbreathing Engine Cowl

Glass, Christopher E.; January 2003; 9 pp.; In English; 36th AIAA Thermophysics Conference, 23-26 Jun. 2003, Orlando, FL, USA

Report No.(s): AIAA Paper 2003-3772; Copyright; Avail: Other Sources

The direct simulation Monte Carlo method is used to investigate hypersonic shock- shock interactions on a simulated 2-D SCRAMjet engine cowl, the purpose of which is to push to the higher altitude, upper bound of the airbreathing propulsion flight corridor. It is important to capture the non-continuum, high temperature effects for these flow phenomena because they produce inordinately high heating levels and loads that need to be accurately defined for proper sizing of active or passive cowl lip cooling systems. Because of small radius cowl leading edges (r approximately equal to 2.5 mm) on airbreathing hypersonic vehicles, non-continuum effects may be produced at near continuum conditions. Thus, a molecular simulation should be utilized to best capture the flow physics of the phenomena. The unique dataset for flight conditions presented shows the detailed effects of the non-continuum shock interaction on the flow field and surface pressure and heat transfer, including such effects as those produced by the large gradients through the bow shock.

Author

Air Breathing Engines; Hypersonic Shock; Aerothermodynamics; Leading Edges; Shock Wave Interaction; Computerized Simulation; Cowlings; Supersonic Combustion Ramjet Engines

20030060647 NASA Marshall Space Flight Center, Huntsville, AL, USA

The Altus Cumulus Electrification Study (ACES): A UAV-Based Science Demonstration

Blakeslee, R. J.; Croskey, C. L.; Desch, M. D.; Farrell, W. M.; Goldberg, R. A.; Houser, J. G.; Kim, H. S.; Mach, D. M.; Mitchell, J. D.; Stoneburner, J. C.; [2003]; 1 pp.; In English; International Conference on Atmospheric Electricity 2003, 9-13 Jun., 2003, Versailles, France; Copyright; Avail: Other Sources; Abstract Only

The Altus Cumulus Electrification Study (ACES) is an unmanned aerial vehicle (UAV)- based project that investigated thunderstorms in the vicinity of the Florida Everglades in August 2002. ACES was conducted to investigate storm electrical activity and its relationship to storm morphology, and to validate satellite-based lightning measurements. In addition, as part of the NASA sponsored UAV-based science demonstration program, this project provided a scientifically useful demonstration of the utility and promise of UAV platforms for Earth science and applications observations. ACES employed the Altus II aircraft, built by General Atomics - Aeronautical Systems, Inc. Key science objectives simultaneously addressed by ACES are to: (1) investigate lightning-storm relationships, (2) study storm electrical budgets, and provide Lightning Imaging Sensor validation. The ACES payload included electrical, magnetic, and optical sensors to remotely characterize the lightning activity and the electrical environment within and around thunderstorms. ACES contributed important electrical and optical measurements not available from other sources. Also, the high altitude vantage point of the UAV observing platform (up to 55,000 feet) provided cloud-top perspective. By taking advantage of its slow flight speed (70 to 100 knots), long endurance, and high altitude flight, the Altus was flown near, and when possible, over (but never into) thunderstorms for long periods of time that allowed investigations to be conducted over entire storm life cycles. An innovative real time weather system was used to identify and vector the aircraft to selected thunderstorms and safely fly around these storms, while, at the same time monitor the weather near our base of operations. In addition, concurrent ground-based observations that included radar (Miami

and Key West WSRBD, NASA NPOL), satellite imagery, and lightning (NALDN and Los Alamos EDOT) enable the UAV measurements to be more completely interpreted and evaluated in the context of the thunderstorm structure, evolution, and environment.
Author
Pilotless Aircraft; Thunderstorms; Weather Forecasting; Electrical Measurement; Satellite Imagery

02
AERODYNAMICS

Includes aerodynamics of flight vehicles, test bodies, airframe components and combinations, wings, and control surfaces. Also includes aerodynamics of rotors, stators, fans, and other elements of turbomachinery. For related information see also *34 Fluid Mechanics and Thermodynamics*.

20030061111 Air Force Research Lab., Wright-Patterson AFB, OH
Unsteady Shock Wave - Boundary Layer Interactions FY 2000 AFOSR entrepreneurial Research Task
Addington, Gregory; Copenhaver, William W.; Dec. 2001; 6 pp.; In English
Contract(s)/Grant(s): Proj-2307
Report No.(s): AD-A412849; AFRL-VA-WP-TM-2003-3016; No Copyright; Avail: CASI; A02, Hardcopy

The objective of the research performed was to investigate shock - boundary layer interactions at transonic conditions in the presence of unsteady vortex flows originating upstream of the shock location. These conditions are germane to both external and internal flows: principally, flows over a geometry representative of a modern fighter wing at transonic maneuvering conditions and within transonic compressor states, respectively. Despite intentions to the contrary, these conditions were studied separately as it was determined that insufficient overlap existed for the computational tools and conditions of choice.
DTIC
Shock Waves; Boundary Layers; Unsteady Flow

20030061173 ASBL Renaissance, Brussels, Belgium
Air-Launch TSTO With Subsonic In-Flight Collection-System and Technology Study
Hendrick, Patrick; January 30, 2003; 181 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F61775-01-WE074
Report No.(s): AD-A410817; SPC01-4074; No Copyright; Avail: CASI; A09, Hardcopy

This report results from a contract tasking ASBL Renaissance as follows: A conceptual aircraft design tool called RDS will be used in parallel with the (Royal Military Academy) RMA-developed trajectory-sizing tool. The purpose will be to analyze the variants of the Gross Weight evolution in flight using the ACES concept together with the loads existing on the aircraft and the influence on the aircraft structural design and thus its empty weight with a constant feedback into the trajectory code and the mission payload calculation. A specially designed aircraft based on civil airliner components will be used in the study. This conceptual aircraft together with its orbiter or alone has to cruise during rather long periods (2 to 4 hours). The impact of the possible aircraft volume and thus drag increase due to the high hydrogen content must be studied attentively as well as the possibility for the aircraft to reach 10 km altitude at Mach 0.75-0.80 and fly at these conditions. This analysis will be done using well-known and robust commercial software called AAA. For cruising in these conditions, a hydrogen fueled turbofan is almost mandatory. The feasibility study and the design of such a high by-pass ratio turbofan would also be part of this study (using the commercial software Gasturb and GSP). The LOX collection plant will also be analyzed. The simulation tool developed for the supersonic collection will be used to calculate the performance of the required collection plant in these collecting conditions. The possible icing problem of the pre-coolerwill also be analyzed in these collection conditions. The sizing code developed by ERM for SSTO and TSTO with supersonic staging would be extended to study different cases of this subsonic ACES vehicle.
DTIC
Aircraft Design; Single Stage To Orbit Vehicles; Launch Vehicles; Technology Utilization; Subsonic Aircraft; Systems Engineering

20030061354 Worcester Polytechnic Inst., MA, USA
Aerodynamics of Parachute Opening
Johari, Hamid; Desabrais, K. J.; Jul. 25, 2002; 131 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): DAAG55-98-1-01771
Report No.(s): AD-A411095; ARO-37594.6-EG; No Copyright; Avail: CASI; A07, Hardcopy

The velocity field in the near wake of a small-scale, flexible, flat circular parachute canopy was measured by the particle image velocimetry method. The experiments were performed in a water tunnel with the Reynolds number ranging from 3.0-6.0 x10(4). Both a fully inflated canopy and the inflation phase were investigated. The fully inflated canopy experienced a cyclic 'breathing' motion with a normalized frequency of 0.56 +/- 0.03, which corresponded to the shedding of vortex rings from the canopy. The boundary layer formed on the canopy surface begins to separate near the apex region when the diameter is approximately 68\% of the fully inflated diameter.
DTIC
Parachutes; Parachute Descent; Aerodynamics

03
AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; airport ground operations; flight safety and hazards; and aircraft accidents. Systems and hardware specific to ground operations of aircraft and to airport construction are covered in *09 Research and Support Facilities (Air)*. Air traffic control is covered in *04 Aircraft Communications and Navigation*. For related information see also *16 Space Transportation and Safety* and *85 Technology Utilization and Surface Transportation*.

20030059523 Massachusetts Inst. of Tech., Lexington, MA, USA
Observations of Non-traditional Wind Shear Events at the Dallas/Fort Worth International Airport
Shaw, J.; Miller, D.; Collins, B.; Isaminger, M.; Feb. 28, 2003; In English
Report No.(s): PB2003-102918; ATC-308; No Copyright; Avail: National Technical Information Service (NTIS)

During the past 20 years there has been great success in understanding and detecting microbursts. These 'traditional' wind shear events are most prominent in the summer and are characterized by a two-dimensional, divergent outflow associated with precipitation loading from a thunderstorm downdraft or evaporative cooling from high-based rain clouds. Analysis of wind shear loss alerts at the Dallas/Fort Worth International Airport (DFW) from August 1999 through July 2002 reveals that a significant number of wind shear events were generated by 'non-traditional' mechanisms. The 'non-traditional' wind shear mechanisms, linear divergence, divergence behind gust fronts, and gravity waves, accounted for one half of the alert events in the period studied. Radar-based algorithms have shown considerable skill in detecting wind shear events. However, the algorithms were developed to identify features common to the 'traditional' events. If the algorithms were modified to detect 'non-traditional' wind shear, the corresponding increase in false detections could be unacceptable. Therefore, in this report a new radar-based algorithm is proposed that detects linear divergence, divergence behind gust fronts, and gravity waves for output on the Integrated Terminal Weather System by identifying the radar signatures that are common to these features.
NTIS
Wind Shear; Algorithms; Radar Data; Microbursts (Meteorology); Airports

20030061350 Naval Health Research Center, Wright-Patterson AFB, OH, USA
Known Harmful Effects of Constituents of Jet Oil Smoke
Bobb, Andrew J.; Still, Kenneth R.; Feb. 2003; 11 pp.; In English
Report No.(s): AD-A411032; TOXDET-03-04; No Copyright; Avail: CASI; A03, Hardcopy

The construction of cabin pressurization systems of certain commercial aircraft allows pyrolyzed jet oil to leak into the cabin air, often producing visible smoke. The principal toxic constituents of this smoke are tricresyl phosphate, carbon monoxide, and N-phenyl-L-naphthylamine. Long-term neurological effects alleged by airline workers could be due to tricresyl phosphate and/or carbon monoxide exposure.
DTIC
Commercial Aircraft; Fuel Tank Pressurization; Oils; Jet Engine Fuels; Smoke

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes all stages of design of aircraft and aircraft structures and systems. Also includes aircraft testing, performance, and evaluation, and aircraft and flight simulation technology. For related information see also *18 Spacecraft Design, Testing and Performance*; and *39 Structural Mechanics*. For land transportation vehicles see *85 Technology Utilization and Surface Transportation*.

20030059503 Naval Research Lab., Washington, DC
Requirements for an Aircraft Carrier Flight Deck Fire Fighting Test Facility
Darwin, Robert L.; Scheffey, Joseph L.; Bowman, Howard L.; Williams, Frederick W.; Feb. 20, 2003; 24 pp.; In English
Contract(s)/Grant(s): Proj-61-8257-0-3-5
Report No.(s): AD-A412313; NRL/MR/6180--03-8660; No Copyright; Avail: CASI; A03, Hardcopy

This report outlines the requirements for a flight deck fire fighting facility. This includes mock aircraft, flush deck nozzles, AFFF delivery system, and wind machines. Environmental issues are detailed.
DTIC
Aircraft Carriers; Fire Fighting; Test Facilities

20030060406 NASA Langley Research Center, Hampton, VA, USA
A Study of the Mechanical Properties of Modern Radial Aircraft Tires
Daugherty, Robert H.; May 2003; 103 pp.; In English
Contract(s)/Grant(s): 762-10-33-03
Report No.(s): NASA/TM-2003-212415; L-18286; NAS 1.15:212415; No Copyright; Avail: CASI; A06, Hardcopy

An experimental investigation was conducted at the NASA Langley Research Center to study the effects of various parameters on the mechanical properties of a number of modern radial aircraft tires such as would be found in the present commercial transport aircraft fleet. The range of tire sizes encompasses most of the tires that would be observed on both nose-and main-landing gear installations. Three radial tire sizes were tested and found to behave similarly in terms of static load-deflection when the results were non-dimensionalized. Footprint areas and rolling radii were found not to be very sensitive to either forward speed or variations in inflation pressure within a rather large range of pressures designed to simulate 80 Fahrenheit degrees of temperature change from origin to destination for a flight. The radial aircraft tires were found to behave like most other tires in response to variations in vertical load and yaw angle. The side-force coefficient, which is a measure of cornering efficiency, was found to increase with increases in yaw angle and decrease with increases in vertical load. A single model to provide a predictive capability for the side force coefficient, regardless of tire size, is presented.
Author
Aircraft Tires; Commercial Aircraft; Mechanical Properties; Test Facilities; Aircraft Design

20030060420 Massachusetts Inst. of Tech., Cambridge, MA
System Design Implementation in the Aircraft Manufacturing Industry
Hendricks, Steven D.; Sep. 2002; 106 pp.; In English
Report No.(s): AD-A412297; MIT-CI02-825; No Copyright; Avail: CASI; A06, Hardcopy

The central theme of this thesis is that desired business results are the direct result of the system design (Cochran, et. al, April 2002). It is also theorized that the thinking' within an organization creates the organization's structure' or design, which then drives the system's behavior' (Cochran, et. al, April 2002). It is concluded that the behavior, actions, performance, quality, cost, culture and classifications describing systems as either mass' or lean' are solely the results of the system's design or structure. Achievement of enduring change in a system's performance must begin with a change in the thinking of all the people in the enterprise, but especially that of leadership. In the absence of such a change in the thinking, the needed structural change within the system will be short-lived, only resulting in localized optimization of sub-systems versus systemic improvement. Two types of thinking, mass thinking' and system thinking,' are defined and analyzed with respect to their structure and resulting behavior. The unit cost equation exemplifies the structure within mass systems resulting in business results being more unpredictable. Axiomatic design is presented as the way of structuring or design methodology to best reflect, understand and control the complexity inherent in the design of large-scale integrated systems. System stability is identified as the desired objective of system design. The Product Delivery System (PDS) is applied in a case study comparing the before' and after' state of the redesign of a manufacturing cell. Direct correlation is identified between achievement of PDS requirements and improved system performance. Research based on the logical system design as defined by the PDS also was used to develop and apply an investment and resource allocation methodology to support manufacturing system design

implementation. The methodology is a new approach that can be used by a company with constrained investment
DTIC
Aircraft Industry; Manufacturing

20030060424 Environmental Quality Management, Inc., Cincinnati, OH, USA
PT6A-68 Emissions Measurement Program Summary
Wade, Mark D.; Gerstle, Tom; Sep. 2002; 260 pp.; In English
Contract(s)/Grant(s): F41624-95-D-9019
Report No.(s): AD-A412301; IERA-RS-BR-SR-2002-0003; No Copyright; Avail: CASI; A12, Hardcopy

The Report is the product of a five year emissions testing program designed to document, characterize, and evaluate emissions from aircraft engines, auxiliary power units (APU's) burning JP-8. The purpose of the emissions testing program was to develop emission factors for the tested engines under representative load conditions. This addendum is for the PT6A-68 aircraft engine test program. Testing was performed by Environmental Quality Management, Inc. (EQM). Testing was conducted for criteria and hazardous air pollutants.
DTIC
Emission; Aircraft Engines

20030060490 Cranfield Univ., UK
Novel Robust Models for Damage Tolerant Helicopter Components
Lang, M.; Irving, P. E.; Stolz, C.; Zitounis, V.; Dec. 2002; 65 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): N68171-01-C-9015
Report No.(s): AD-A411960; DT9623/55; No Copyright; Avail: CASI; A04, Hardcopy

A new approach to the prediction of crack growth fatigue lives under variable amplitude loading, the K(PR) approach, is described. K(PR) is the minimum stress intensity for crack propagation during a loading cycle and is sensitive to the immediate loading history at the crack tip. Four parameters describe changes in K(PR) as a function of load history. Unlike other models the KPR model has no fitting parameter. The four KPR parameters for 7010-T73651 aluminium and SAE 4340 quenched and tempered steel, together with necessary crack growth rate data, were measured. Variable amplitude testing was performed on the same materials under two loading spectra, Rotarix, a standard spectrum for a helicopter rotorhead, and Falstaff, a fixed wing fighter aircraft spectrum. The variable amplitude crack growth data were used to validate the K(PR) model together with 4 other models for fatigue crack growth. These were FASTRAN, the 3 models within AFGROW, namely, Wheeler, Willenborg and the closure model. It was found that the K(PR) model provided the best agreement for Rotarix on 7010 aluminium, with errors of only 15-20\%. FASTRAN was second best. All other models made non conservative predictions. On Falstaff, agreement was not as good on aluminium alloys, but K(PR) was still the most accurate model The KPR model performed not as well on the SAE 4340 steel. For Rotarix. K(PR)still was the closest, for Falstaff, other models achieved better accuracy. All predictions were made blind, in advance of knowledge of the validation test data.
DTIC
Helicopters; Fighter Aircraft; Robustness (Mathematics); Damage; Structural Analysis

20030060643 NASA Marshall Space Flight Center, Huntsville, AL, USA
Base-Bleed Effect on X-33 Aerospike Plume Induced Base-Heating Environment During Power-Pack Out
Wang, Tee-See; Droege, Alan; D'Agostino, Mark; Lee, Young-Ching; Williams, Robert; [2003]; 36 pp.; In English; 36th AIAA Thermophysics Conference, 23-26 Jun. 2003, Orlando, FL, USA; No Copyright; Avail: CASI; A03, Hardcopy

A computational heat transfer methodology was developed to study the dual-engine linear aerospike plume induced base-heating environment during one power-pack out, in ascent flight. One power-pack out results in reduction of power levels for both engines. That, in turn, reduces the amount of base-bleed and changes the distribution of base-bleed on the two pillows. Hence, the concern of increased base-heating during power-pack out. The thermo-flowfield of the entire vehicle was computed. The computational methodology for the convective heating is based on a three-dimensional, finite-volume, viscous, chemically reacting, and pressure-based computational fluid dynamics formulation. The computational methodology for the radiative heating is based on a three-dimensional, finite-volume, and spectral-line-based weighted-sum-of-gray-gases absorption computational radiation heat transfer formulation. A separate radiation model was used for diagnostic purposes. The computational methodology was systematically benchmarked. In this study, near-base radiative heat fluxes were computed and they compared well with those measured from an installed linear aerospike engine tests. The base-heating environment of 18 trajectory points selected from three power-pack out ascent scenarios was computed and is presented here.

The power-pack out condition has the most impact on convective base-heating when it happens early in flight. The some of its impact comes from the asymmetric and reduced base-bleed.
Author
Aerospike Engines; X-33 Reusable Launch Vehicle; Base Heating; Plumes

20030060680 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Combining and Analyzing the Tanker and Aircrew Scheduling Heuristics
Boke, Cem; March 2003; 83 pp.; In English
Report No.(s): AD-A412689; AFIT/GOR/ENS/03-04; No Copyright; Avail: CASI; A05, Hardcopy

Air refueling is an integral part of U,S air power across a wide range of military operations. It is an essential capability in the conduct of air operations worldwide and is especially important when overseas basing is limited or not available. The planning, tasking, and scheduling of aerial refueling require solution of two major problems: assigning and scheduling of tankers to refueling points and efficiently assigning crews to each tanker. To address the scheduling of tankers, Wiley (2001) developed an efficient tabu search approach. Combs (2002) developed another tabu search approach to assign crews to tankers. This research combines the two scheduling heuristics so that the tanker schedules generated by the tanker scheduling heuristics can feed the crew scheduling heuristic.
DTIC
Scheduling; Tanker Aircraft; Air To Air Refueling

20030060698 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Multimission Aircraft Design Study, Payload
Kahraman, Ahmet; Mar. 2003; 227 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412756; AFIT/GSE/ENY/03-2; No Copyright; Avail: CASI; A11, Hardcopy

It is proposed that a Multi-Mission Aircraft (MMA) be prepared to combine some or all the functions of the aging AWACS, JSTARS, RIVET JOINT, COMPASS CALL, and AECCC fleet. Three different thesis studies have been developed by three Air Force Institute of Technology GSE students to show the feasibility of replacing the current aging fleet with one or more MMA platforms. This is the thesis in which the payload issuer have been examined. Within this thesis, two different alternative architectures, which are One Tail Number and Different Tail Numbers including nine different configurations, have been considered. Estimated payload characteristics of these alternatives have been compared to those of Boeing 767-400ER, which is the aircraft selected as the baseline for MMA platform. Reduced life cycle cost, increased measure of aircraft specifications, and minimum risk are the main objectives pursued by means of several systems engineering and aircraft design methodologies.
DTIC
Systems Engineering; Electronic Aircraft; Reconnaissance Aircraft; Payloads

20030061107 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA
Distributed Modeling and Control of Adaptive Wings
Inman, Daniel J.; March 10, 2003; 7 pp.; In English
Contract(s)/Grant(s): F49620-99-1-0294
Report No.(s): AD-A412820; No Copyright; Avail: CASI; A02, Hardcopy

New generations of highly-maneuverable aircraft, such as Uninhabited Combat Air Vehicles (UCAV) or Micro Air Vehicles (MAV), are likely to feature very flexible lifting surfaces. In order to enhance their stealth properties and maneuverability, the possibility of using smart wings and morphing airfoils instead of conventional, hinged control surfaces is investigated. This task requires a fundamental understanding of the interaction between fluid, structure and control system, in a coded form that is fast enough to design with. This DARPA-funded project takes a fundamental approach to understanding the relevant physical phenomena using different models of a flying wing vehicle in flight. We have developed a model that is consistent with distributed control, and have exercised this model to determine what progress is possible in terms of flight control (lift, drag, and maneuver performance) with morphing wings. For this purpose, different modeling levels are examined and combined with a variety of distributed control approaches to determine exactly what types of maneuvers and flight regimes may be possible, and to determine the forces, moments, and deflections that would be needed from the actuation community in order to fly an aircraft completely without the use of discrete control surfaces. This year's progress has been to bring

together several elements (aerodynamics, flight dynamics, shape generation, and control) to determine bounds on the required forces, moments and strokes for flying by morphing.
DTIC
Wings; Drone Aircraft; Adaptive Control

20030061112 Lockheed Martin Aeronautics Co., Fort Worth, TX, USA
A Sensor Integration Technique for Preventing Collisions between Air Vehicles
Griffin, Edward; Swihart, Donald E.; Braennstroem, Bertil; Rosenbren, Ragnar; Doane, Paul; Jun. 2002; 7 pp.; In English
Contract(s)/Grant(s): F33615-01-2-3103; F33615-01-2-3101; Proj-486U
Report No.(s): AD-A412853; AFRL-VA-WP-TP-2002-318; No Copyright; Avail: CASI; A02, Hardcopy

The use of data links to control unmanned air vehicles (UAVs) from ground controllers over the past several years has become an important concept for military operations. Currently, multiple UAV flights are not performed due to mission requirements. Control algorithm designs can be achieved to provide for multiple UAV operations, but unforeseen circumstances such as ground controllers flying the wrong course could cause air vehicles to arrive in the same airspace at the same time, which could cause a collision. This paper will discuss the integration of data links in the design of an Automatic Air Collision Avoidance System (Auto ACAS) for aircraft, which are intended to prevent air-to-air collisions between air vehicles. This system is not intended to replace existing designs such as the Traffic Alert and Collision Avoidance System (TCAS), but to accomplish a recover at the last instant to prevent a collision.
DTIC
Collision Avoidance; Drone Aircraft

20030061115 AIR FORCE INST. OF TECH WRIGHT-PATTERSON AFB OH, Wright-Patterson AFB, OH, USA
Multimission Aircraft Design Study: Electromagnetic Compatibility
Davis, Jenna M.; 25 Mar. 2003; 129 pp.; In English
Report No.(s): AD-A412691; AFIT/GAI/ENY/03-01; No Copyright; Avail: CASI; A07, Hardcopy

The multi-mission aircraft (MMA) technical feasibility study looked at the replacement of the aging fleet of C-135 and C-130 theater based command & control (C2) and intelligence, surveillance and reconnaissance (ISR) fleet. It is proposed that the MMA be out-fitted to combine some or all the functions of existing AWACS, JSTARS, RIVET JOINT, COMPASS CALL, and ABC CC platforms. It would also have links to other manned or unmanned ISR aircraft, as well as satellites. The objective of the proposed design study is to examine the technical risks involved in combining multiple functions onto one aircraft that currently reside on separate aircraft. This thesis specifically focused on the risks that are due to electromagnetic interference between transmitters and interference between active and passive sensors. Two architectures were examined: one tail number (OTN) and different tail number (DTN), The OTN architecture was found to be incompatible due to interference between the air moving target indicator transmit and high band receive functions, whereas, the DTN was found to be compatible for all variant architectures.
DTIC
Military Aircraft; Transport Aircraft; Electromagnetic Compatibility

20030061165 Naval Air Warfare Center, Patuxent River, MD
F/A-18E/F Nacelle Simulator Input/Output Boundary Condition Flows
Dolinar, Joseph; Hudgins, David; Keyser, David; Oct. 16, 2002; 32 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412671; NAWCADPAX/SUM-2002/171; No Copyright; Avail: CASI; A03, Hardcopy

These tests were conducted to determine the distribution of airflows, without fire, across the boundary of the fire test nacelle. As a check on the overall accuracy of these flow measurements, a mass balance was performed as well. These data provide the boundary conditions for the Computational Fluid Dynamics models of this nacelle simulator. The proportional distribution of air effluxes remained nearly constant throughout the range of inlet flows and, therefore, the actual mass flows are nearly proportional to the total inflow.
DTIC
Air Flow; Nacelles; Engine Inlets

20030061193 Lockheed Martin Aeronautics Co., Fort Worth, TX, USA
Integration Techniques for Preventing Collisions between Air Vehicles
Swihart, Donald E.; Nguyen, Ba; Griffin, Edward; Braennstroem, Bertil; Dec. 2002; 9 pp.; In English
Contract(s)/Grant(s): F33615-01-02-3101; F33615-01-2-3103
Report No.(s): AD-A412855; AFRL-VA-WP-TP-2002-332; No Copyright; Avail: CASI; A02, Hardcopy

The use of data links to control Unmanned Air Vehicles (UAVs) from ground controllers over the past several years has become an important concept for military operations. Currently, multiple UAV flights are not performed due to the possibility of air-to-air collisions. Control algorithm designs can be achieved to provide for multiple UAV operations, but unforeseen circumstances such as ground controllers flying the wrong course could cause air vehicles to arrive in the same airspace at the same time, which could cause a collision.
DTIC
Collisions; Data Links; Pilotless Aircraft; Airspace

20030061273 Stanford Univ., Stanford, CA
Annual Research Briefs, 2002: Center for Turbulence Research
Moin, Parviz; Mansour, Nagi N.; Bradshaw, Peter; December 2002; 436 pp.; In English
Contract(s)/Grant(s): NCC2-1371
Report No.(s): AD-A412687; No Copyright; Avail: CASI; A19, Hardcopy

Turbulent combustion remains the largest component of the CTR's core program. This program and several related activities at CTR are supported by NASA's Ultra Efficient Engine Technology Program. It is also intimately connected with the Department of Energy's ASCI program at Stanford which develops the technology for numerical simulation of realistic aircraft engines using state of the art massively parallel computers. In combustion modeling the attention has been directed to the modeling of higher levels of complexity such as spray dynamics, radiation and soot formation. Major aircraft engine manufacturers have shown considerable interest in this program; in particular, a significant active collaboration exists between CTR and the Pratt & Whitney Corporation. CTR's combustion program is essentially based on the large-eddy simulation technique, LES, which is actively being pursued at CTR for this and many other applications. Important accomplishments in LES included simulations with three-dimensional filters which result in grid independent calculations (that is why we call it 'true' LES), and the development of the methodology for integration of LES and Reynolds Averaged computations. Optimization techniques are being studied and used for the important problem of wall boundary conditions for LES as well as for optimal shape design for aeroacoustic and aerodynamic performance gains.
DTIC
Aircraft Engines; Turbulence; Combustion

20030061288 Defence Science and Technology Organisation, Fishermans Bend, Australia
A Proposed Highly Damped Repair for the Aft Fuselage of the F/A-18
Callinan, R. J.; Galea, S. C.; Sanderson, S.; December 2002; 28 pp.; In English
Report No.(s): DSTO-TR-1374; DODA-AR-012-524; Copyright; Avail: Other Sources

Currently an increasing number of RAAF F/A-18 aircraft are developing acoustic fatigue cracks on the rear fuselage. Acoustic fatigue is the result of high frequency lateral vibration of an aircraft panel as a result of time varying pressure waves caused by engine and/or aerodynamic effects. While the exact broadband power spectral density (PSD) spectrum is not available for this area of the the F/A-18, the PSD is known for the inlet nacelle area in which cracking has occurred. Cracking in the inlet nacelle proceeded cracking in the aft fuselage by a period of several years. As a result the inlet nacelle experiences a more severe spectrum and is the PSD adopted here. Viscoelastic damping materials are used in this repair in conjunction with the constrained layer technique to reduce the lateral vibration. Since viscoelastic materials have a limited temperature range it has been necessary to use two types of damping materials to cover the expected temperature range. A highly damped repair is proposed for the aft fuselage area and is shown to be significantly effective in reducing the crack growth rate.
Author
Acoustic Fatigue; Fuselages; Mechanical Properties; Cracking (Fracturing); Thermal Environments; F-18 Aircraft; Viscoelastic Damping

06
AVIONICS AND AIRCRAFT INSTRUMENTATION

Includes all avionics systems, cockpit and cabin display devices, and flight instruments intended for use in aircraft. For related information see also *04 Aircraft Communications and Navigation; 08 Aircraft Stability and Control; 19 Spacecraft Instrumentation and Astrionics*; and *35 Instrumentation and Photography*.

20030060641 NASA Glenn Research Center, Cleveland, OH, USA, Rockwell Collins, Inc., Cedar Rapids, IA, USA, Rockwell Collins, Inc., Cedar Rapids, IA, USA

Enhanced Weather Radar (EWxR) System

Kronfeld, Kevin M., Technical Monitor; June 06, 2003; 19 pp.; In English

Contract(s)/Grant(s): NCC1-335; 728-40-10-30

Report No.(s): NASA/CR-2003-212406; NAS 1.26:212406; No Copyright; Avail: CASI; A03, Hardcopy

An airborne weather radar system, the Enhanced Weather Radar (EWxR), with enhanced on-board weather radar data processing was developed and tested. The system features additional weather data that is uplinked from ground-based sources, specialized data processing, and limited automatic radar control to search for hazardous weather. National Weather Service (NWS) ground-based Next Generation Radar (NEXRAD) information is used by the EWxR system to augment the on-board weather radar information. The system will simultaneously display NEXRAD and on-board weather radar information in a split-view format. The on-board weather radar includes an automated or hands-free storm-finding feature that optimizes the radar returns by automatically adjusting the tilt and range settings for the current altitude above the terrain and searches for storm cells near the atmospheric 0-degree isotherm. A rule-based decision aid was developed to automatically characterize cells as hazardous, possibly-hazardous, or non-hazardous based upon attributes of that cell. Cell attributes are determined based on data from the on-board radar and from ground-based radars. A flight path impact prediction algorithm was developed to help pilots to avoid hazardous weather along their flight plan and their mission. During development the system was tested on the NASA B757 aircraft and final tests were conducted on the Rockwell Collins Sabreliner.

Author

Meteorological Radar; Weather; Meteorological Parameters; Systems Engineering; Flight Tests; Display Devices

07
AIRCRAFT PROPULSION AND POWER

Includes primary propulsion systems and related systems and components, e.g., gas turbine engines, compressors, and fuel systems; and onboard auxiliary power plants for aircraft. For related information see also *20 Spacecraft Propulsion and Power; 28 Propellants and Fuels*; and *44 Energy Production and Conversion*.

20030059515 Auburn Univ., AL, USA

Compatibility Studies of Hydrogen Peroxide and a New Hypergolic Fuel Blend

Baldridge, Jennifer; Villegas, Yvonne; August 09, 2002; 14 pp.; In English; NASA-MSFC 2002 Undergraduate Student Research Program Technical Report Collection, Nov. 2002, Huntsville, AL, USA; No Copyright; Avail: CASI; A03, Hardcopy

Several preliminary materials compatibility studies have been conducted to determine the practicality of a new hypergolic fuel system. Hypergolic fuel ignites spontaneously as the oxidizer decomposes and releases energy in the presence of the fuel. The bipropellant system tested consists of high-test hydrogen peroxide (HTP) and a liquid fuel blend consisting of a hydrocarbon fuel, an ignition enhancer and a transition metal catalyst. In order for further testing of the new fuel blend to take place, some basic materials compatibility and HTP decomposition studies must be accomplished. The thermal decomposition rate of HTP was tested using gas evolution and isothermal microcalorimetry (IMC). Materials were analyzed for compatibility with hydrogen peroxide including a study of the affect welding has on stainless steel elemental composition and its relation to HTP decomposition. Compatibility studies of valve materials in the fuel blend were performed to determine the corrosion resistance of the materials.

Derived from text

Hydrogen Peroxide; Mixtures; Aircraft Fuel Systems; Hypergolic Rocket Propellants; Fuel Systems

20030061085 Boeing Commercial Airplane Group, Seattle, WA, USA

Ultra-Efficient Engine Diameter Study

Daggett, David L.; Brown, Stephen T.; Kawai, Ron T.; May 2003; 63 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): NAS3-01140; WBS-22-714-08-02

Report No.(s): NASA/CR-2003-212309; NAS 1.26:212309; E-13893; Copyright; Avail: CASI; A04, Hardcopy

Engine fan diameter and Bypass Ratio (BPR) optimization studies have been conducted since the beginning of the turbofan age with the recognition that reducing the engine core jet velocity and increasing fan mass flow rate generally increases propulsive efficiency. However, performance tradeoffs limit the amount of fan flow achievable without reducing airplane efficiency. This study identifies the optimum engine fan diameter and BPR, given the advanced Ultra-Efficient Engine Technology (UEET) powerplant efficiencies, for use on an advanced subsonic airframe. Engine diameter studies have historically focused on specific engine size options, and were limited by existing technology and transportation infrastructure (e.g., ability to fit bare engines through aircraft doors and into cargo holds). This study is unique in defining the optimum fan diameter and drivers for future 2015 (UEET) powerplants while not limiting engine fan diameter by external constraints. This report follows on to a study identifying the system integration issues of UEET engines. This Engine Diameter study was managed by Boeing Phantom Works, Seattle, Washington through the NASA Glenn Revolutionary Aero Space Engine Research (RASER) contract under task order 10. Boeing Phantom Works, Huntington Beach, completed the engine/airplane sizing optimization, while the Boeing Commercial Airplane group (BCA) provided design oversight. A separate subcontract to support the overall project was issued to Tuskegee University.
Author
Bypass Ratio; Turbofans; Mass Flow Rate; Aircraft Engines; Propulsive Efficiency; Jet Flow

20030061182 Missouri Univ., Rolla, MO, USA
Turbofan Noise Propagation and Radiation at High Frequencies
Koch, Danielle, Technical Monitor; Eversman, Walter; May 2003; 23 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): NAG3-2718; WU 708-87-23
Report No.(s): NASA/CR-2003-212323; E-13917; NAS 1.26:212323; No Copyright; Avail: CASI; A03, Hardcopy

This report summarizes progress on NASA Glenn Research Center Grant NAG3-2718 to the University of Missouri at Rolla This grant was awarded on February 22, 2002 and this report covers the performance period to September 30, 2002. There is considerable overlap in research effort with previous NASA Glenn Grant NAG3-2340, as the current effort represents a continuation and extension of this previous grant, which with a no cost supplement terminated on January 31, 2002. This report outlines progress on each task in the original proposal. In addition to progress on several of the specifically proposed tasks, considerable progress has been made in FEM algorithm development with the intent of introducing computational efficiencies required to model high frequency propagation and radiation and to open the possibility of expanding the scope of the modeling capability to three dimensional duct and nacelle geometries. Appended to this document is a paper presented at the 8th AIAA/CEAS Aeroacoustics Conference in June 2002. This paper overlaps the present grant and the previous grant identified above, and it is noted that this paper has also been appended to the final report for NAG3-2304.
Author
Turbofans; Noise Propagation; Short Wave Radiation; High Frequencies; Aeroacoustics

09
RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, runways, hangars, and aircraft repair and overhaul facilities; wind tunnels, water tunnels, and shock tubes; flight simulators; and aircraft engine test stands. Also includes airport ground equipment and systems. For airport ground operations see *03 Air Transportation and Safety*. For astronautical facilities see *14 Ground Support Systems and Facilities (Space)*.

20030060444 Arnold Engineering Development Center, Arnold AFS, TN
Free-Piston Shock Tunnel Test Technique Development: An AEDC/DLR cooperative Program
Stallings, D. W.; Williams, W. D.; Felderman, E. J.; Feb. 2003; 240 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412642; AEDC-TR-01-5; No Copyright; Avail: CASI; A11, Hardcopy

Arnold Engineering Development Center (AEDC) and the German Aerospace Institute (DLR) have conducted a cooperative program on operation and test technique development for high enthalpy shock tunnels. The AEDC Free-Piston Shock Tunnel (FPST) and the DLR High Enthalpy Gottingen (HEG) facility were used for complementary test programs. The two organizations individually and jointly analyzed data from these tests to assess and advance the state of their computational fluid dynamics capabilities. Several nonintrusive diagnostic techniques were employed at each facility resulting in new and improved diagnostic capabilities for each partner. This report explains the organization of the joint program reviews the operation of free-piston shock tunnels and presents the results of data acquisition and analysis from the test programs.
DTIC
Pistons; Shock Tunnels

20030061126 NASA Langley Research Center, Hampton, VA, USA
Survey of Primary Flow Measurement Parameters at the NASA Langley Transonic Dynamics Tunnel
Piatak, David J.; June 2003; 81 pp.; In English
Contract(s)/Grant(s): 762-20-41-02
Report No.(s): NASA/TM-2003-212413; NAS 1.15:212413; L-18282; No Copyright; Avail: CASI; A05, Hardcopy

An assessment of the methods and locations used to measure the primary flow conditions in the NASA Langley Transonic Dynamics Tunnel was conducted during calibration activities following the facility conversion from a Freon-12 heavy-gas test medium to R-134a. A survey of stagnation pressure, plenum static pressure, and stagnation temperature was undertaken at many pertinent locations in the settling chamber, plenum, and contraction section of the wind tunnel and these measurements were compared to those of the existing primary flow measurement systems. Local flow velocities were measured in the settling chamber using a pitot probe. Results illustrate that small discrepancies exist between measured primary tunnel flow conditions and the survey measurements. These discrepancies in tunnel stagnation pressure, plenum pressure, and stagnation temperature were found to be approximately +/- 1-3 psf and 2-3 degrees Fahrenheit. The propagation of known instrument errors in measured primary flow conditions and its impact on tunnel Mach number, dynamic pressure, flow velocity, and Reynolds number have been investigated analytically and shown to require careful attention when considering the uncertainty in measured test section conditions.
Author
Transonic Wind Tunnels; Flow Measurement; Stagnation Pressure; Static Pressure; Stagnation Temperature

12
ASTRONAUTICS (GENERAL)

Includes general research topics related to space flight and manned and unmanned space vehicles, platforms or objects launched into, or assembled in, outer space; and related components and equipment. Also includes manufacturing and maintenance of such vehicles or platforms. For specific topics in astronautics see *categories 13 through 20*. For extraterrestrial exploration see *91 Lunar and Planetary Science and Exploration*.

20030059825 Air Force Scientific Advisory Board, Washington, DC, USA
A Space Roadmap for the 21st Century Aerospace Force, Volume 1, Summary
Borky, John; Ballhaus, William; Brown, Alison; Crawford, Natalie; Dougherty, Llewellyn; Nov. 1998; 101 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412612; SAB-TR-98-01; No Copyright; Avail: CASI; A06, Hardcopy

The Air Force Scientific Advisory Board (SAB) produced this study. The Chief of Staff of the Air Force and Secretary of the Air Force requested and approved the study. It summarizes the Committee-recommended steps the Air Force should take to make the best use of space in accomplishing its assigned operational tasks in a rapidly changing world. While this report stands alone, it builds on the foundation of the Doable Space Quick-Look study led by the Air Force Chief Scientist and it complements the Aerospace Integration Task Force work. This volume starts with an overview of the study tasking, organization and methodology. The next chapter summarizes the challenge confronting the Air Force. The following chapters present the primary findings and recommendations, the results of an initial analysis of budgets to assess the affordability of various future alternatives, and a number of related matters necessary for a complete treatment of the study topic. The final chapter is a summary of the study team s recommended roadmap and program strategy for the future of the Air Force as it learns to conduct functionally seamless operations across the different physical media of air and space.
DTIC
Aerospace Systems; Military Operations

20030059937 SCIENTIFIC ADVISORY BOARD (AIR FORCE) WASHINGTON DC, Washington, DC, USA
Space Surveillance, Asteroids and Comets, and Space Debris, Volume 3, Space Debris Summary Report
Naka, R.; Canavan, G. H.; Clinton, R. A.; Judd, O. P.; Pensa, A. F.; Jun. 1997; 33 pp.; In English
Report No.(s): AD-A412613; SAB-TR-96-04; No Copyright; Avail: CASI; A03, Hardcopy

This Study was produced by the Air Force Scientific Advisory Board (SAB). It was requested by the Commander Air Force Space Command and approved by the Secretary and Chief of Staff of the Air Force. It covers three topics, each of sufficient depth to be a study of its own: Space Surveillance, Asteroid and Comet Impact Warning for Earth, and Space Debris. NASA personnel predicted in 1978 that collisional cascading would be an important source of new orbital debris, possibly before the year 2000, and, as a result, would make low Earth orbits at Space Shuttle altitudes unusable. In 1991, NASA

published an article that said these predictions were reinforced by events in 1986 and 1990. Out of concern that the United Nations might take actions to regulate further the existing Air Force launch debris mitigation procedures, the SAB was asked to recalculate the debris phenomenon. The SAB Committee has shown that cascading is not an issue in the coming hundred years and recommends that the Air Force continue its established launch and on orbit debris mitigation procedures
DTIC
Space Surveillance (Ground Based); Military Operations; Armed Forces (United States)

20030061157 AIR FORCE RESEARCH LAB. EDWARDS AFB CA, Edwards AFB, CA, USA
A University Microsatellite as a MEMS-Based Propulsion Testbed
Ketsdever, Andrew D.; Wong, Joyce; Reed, Helen; Jul. 2000; 22 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A412874; AFRL-PR-ED-TP-2000-110; AIAA-2000-3670; No Copyright; Avail: CASI; A03, Hardcopy

Using reconfigurable and adaptable networks of micro/nanosatellites to support cost-effective space missions is a popular new direction in the space community Micropropulsion systems, which control a satellite's dynamics and attitude, are instrumental to the success of such missions. Since the overall resources available for a micro/nanosatellite are more restricted than for a single large satellite, the micropropulsion system must be lightweight, low power and low cost. This study provides an initial estimate of the mission requirements that drive a micropropulsion design for a university-built microsatellite. It is demonstrated, through a pragmatic joint venture between a university and a government laboratory, that university satellites are an effective testbed for unconventional new technologies. An example of a university satellite that successfully served as a technology demonstration platform as well as an effective education instrument is presented. A follow-on mission, which will be the platform for flight testing a micropropulsion module, is then described. Two candidate micropropulsion systems, the free molecule micro-resistojet and a cold-gas micronozzle, have been studied for applicability to the prescribed mission. The preliminary study concludes that the free molecule micro-resistojet is the more appropriate micropropulsion system for this particular mission.
DTIC
Microelectromechanical Systems; Microsatellites; Spacecraft Propulsion; Resistojet Engines

20030061194 AIR FORCE RESEARCH LAB. EDWARDS AFB CA
Fiber Optic Sensors for the Study of Spacecraft-Thruster Interactions: Ion Sputtering
Ketsdever, Andrew D.; Eccles, Brian M.; Jun. 2001; 12 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A412876; AFRL-PR-ED-TP-2001-171; No Copyright; Avail: CASI; A03, Hardcopy

The interaction between thruster effluents and spacecraft surfaces has received considerable attention recently. Historically, thruster interaction concerns have focused on self-contamination from non-direct and high angle (measured from the thruster centerline) plume impingement. The growing popularity of distributed networks of cooperative, co-orbiting satellite clusters has brought about an additional need to address direct plume impingement or cross-contamination. Typically, quartz crystal microbalances (QCMs) are used to investigate spacecraft-thruster interactions where the major contamination mechanism is the adsorption of molecular species on critical surfaces. New methods are required to investigate the complex nature of plume impingement from advanced ion electric thrusters where the major interaction is the sputtering of critical surfaces. Additionally, QCMs are limited in that they only provide interaction data at a single point; however, the plume characteristics of a typical ion thruster can vary several orders of magnitude over short distances.
DTIC
Fiber Optics; Spacecraft Propulsion; Ion Scattering; Optical Measuring Instruments; Particle Interactions; Ion Engines

20030061301 Atmospheric and Environmental Research, Inc., Lexington, MA, USA
Strategic High Altitude Infrared Backgrounds
Gallery, W. O.; Snell, H. E.; Moncet, J. -L.; Jan. 15, 2001; 8 pp.; In English
Contract(s)/Grant(s): F19628-93-C-0040; Proj-S321
Report No.(s): AD-A410756; AER-P-519; AFRL-VS-TR-2001-1604; No Copyright; Avail: CASI; A02, Hardcopy

The purpose of this contract was to '...provide models and codes to predict infrared background phenomenon to be encountered by advanced space based systems operating in natural and disturbed backgrounds.' The three specific tasks of the contact were: (1) analysis data from the Mid Course Space Experiment (MSX), (2) development of advanced radiance inversion techniques, and (3) enhancement of the radiative transfer program FASCODE Environment (FASE). Under (1), AER

developed experiment plans and detailed data collection event parameters for MSX to obtain vertical profiles of radiance and trace gases in the stratosphere. In addition, AER analyzed data from meteorological satellites coincident with MSX measurements and correlated these data with the MSX data. In (2), AER collaborated with PL/GPOS to analyze radiance data from CIRRIS-II. by enhancing and applying the fast radiative transfer code XFWD and the inversion INV. In (3), AER continued the development of the atmospheric radiative transfer code FASCODE. The new code is called FASE, for FASCODE for the Environment.
DTIC
High Altitude; Infrared Radiation; Spaceborne Experiments; Systems Engineering

13
ASTRODYNAMICS

Includes powered and free flight trajectories; orbital and launching dynamics.

20030060666 Science Applications International Corp., Huntsville, AL, USA
Outer-Planet Mission Analysis Using Solar-Electric Ion Propulsion
Woo, Byoungsam; Coverstone, Victoria L.; Hartmann, John W.; Cupples, Michael; [2003]; 11 pp.; In English; 2003 Space Flight Mechanics Meeting, 9-13 Feb. 2003, Ponce, Puerto Rico
Contract(s)/Grant(s): NASA Order H-35186-D
Report No.(s): AAS-03-242; Copyright; Avail: Other Sources

Outer-planet mission analysis was performed using three next generation solar-electric ion thruster models. Optimal trajectories are presented that maximize the delivered mass to the designated outer planet. Trajectories to Saturn and Neptune with a single Venus gravity assist are investigated. For each thruster model, the delivered mass versus flight time curve was generated to obtain thruster model performance. The effects of power to the thrusters and resonance ratio of Venutian orbital periods to spacecraft period were also studied. Multiple locally optimal trajectories to Saturn and Neptune have been discovered in different regions of the parameter search space. The characteristics of each trajectory are noted.
Author
Solar Electric Propulsion; Trajectory Planning; Trajectory Analysis; Mathematical Models; Thrustors; Trajectory Optimization

14
GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and test chambers and simulators. Also includes extraterrestrial bases and supporting equipment. For related information see also *09 Research and Support Facilities (Air)*.

20030059533 UNIVERSITY OF SOUTHERN CALIFORNIA LOS ANGELES DEPT. OF AEROSPACE AND MECHANICAL ENGINEERING, Los Angeles, CA, USA
Significant Increase in the Cryogenic Pumping System Capacity and Reliability for the CHAFF-IV Plume and Contamination Facility
Muntz, E. P.; Dec. 12, 2002; 21 pp.; In English
Contract(s)/Grant(s): F49620-01-1-0241
Report No.(s): AD-A412533; AFRL-SR-AR-TR-02-0456; No Copyright; Avail: CASI; A03, Hardcopy

The interactions between exhaust plumes and the ambient, high altitude atmosphere have been investigated by the components of the Department of Defense for many years. To date, laboratory investigations of space plumes from firing thrusters and simulated ambient environments have been difficult to achieve due to limitations in pumping speed. The major limitation of ground-based facilities in accurately predicting the effects of thruster operation on spacecraft systems has always been driven by the facility's background pressure. The Chamber-IV of the David P. Weaver Collaborative High Altitude Flow Facility (CHAFF-IV) at the University of Southern California is used for such investigations. One of the critical components of the CHAFF-IV pumping system is a cryogenic helium refrigerator (or cryostat) that supplies gaseous helium at 15 - 20 K to the pumping panels. Higher speed CHAFF-IV pumping for both chemical and electric thrusters allows accurate thruster interaction studies to be performed through the addition of a high capacity commercially available cryostat. Significant increases (approximately a factor of 5) in the pumping speed allows for higher power thrusters (on the order of 10 - 15 kW)

to be operated in the facility. This addition satisfies recent interest in very high power electric ion thrusters and also high flow rate chemical engines operating on advanced (higher temperature) propellants. Additionally, it allows for multiple small thrusters to be fired simultaneously to simulate microspacecraft platoon or constellation formation and operations.
DTIC
Exhaust Gases; Spacecraft Propulsion; Rocket Engines; Plumes

20030060480 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Integration and Test of Shuttle Small Payloads
Wright, Michael R.; January 2003; 34 pp.; In English
Report No.(s): NASA/TM-2003-211611; Rept-2003-00086-0; NAS 1.15:211611; No Copyright; Avail: CASI; A03, Hardcopy

Recommended approaches for space shuttle small payload integration and test (I&T) are presented. The paper is intended for consideration by developers of shuttle small payloads, including I&T managers, project managers, and system engineers. Examples and lessons learned are presented based on the extensive history of NASA's Hitchhiker project. All aspects of I&T are presented, including: (1) I&T team responsibilities, coordination, and communication; (2) Flight hardware handling practices; (3) Documentation and configuration management; (4) I&T considerations for payload development; (5) I&T at the development facility; (6) Prelaunch operations, transfer, orbiter integration and interface testing; (7) Postflight operations. This paper is of special interest to those payload projects that have small budgets and few resources: that is, the truly faster, cheaper, better projects. All shuttle small payload developers are strongly encouraged to apply these guidelines during I&T planning and ground operations to take full advantage of today's limited resources and to help ensure mission success.
Author
Space Shuttle Payloads; Payload Integration; Mission Planning; Prelaunch Tests; Payload Integration Plan; Computer Programs

20030060656 NASA Marshall Space Flight Center, Huntsville, AL, USA
Space Station Science Supported by Marshall Space Flight Center
Whitaker, Ann F.; Curreri, Peter A.; Smith, Tommy R.; [2003]; 1 pp.; In English; AIM Seminar Session IV: Space Station (ISS) Operations Technology and Future Space Science Plans, 15 Mar. 2003, Huntsville, AL, USA; No Copyright; Avail: Other Sources; Abstract Only

The science program at Marshall Space Flight Center will be reviewed in the context of the overall NASA science program. An overview will be given on how Marshall science supports the International Space Station research program. The Microgravity research capabilities at Marshall's Biological and Physical Space Research Laboratory will be reviewed. The environment in orbit provides a unique opportunity to study Materials Science and Biotechnology in the absence of sedimentation and convection. There are a number of peer-selected investigations that have been selected to fly on the Space Station that have been conceived and are led by Marshall civil service and contractor scientists. In addition to Microgravity research the Station will enable research in New Initiative Research Areas that focus on enabling humans to live, work, and explore the solar system safely. The specific scientific instruments that have been developed for Materials Science and Biotechnology Research on the International Space Station will be discussed.
Author
International Space Station; Research Facilities; NASA Programs; Research Projects

15
LAUNCH VEHICLES AND LAUNCH OPERATIONS

Includes all classes of launch vehicles, launch/space vehicle systems, and boosters; and launch operations. For related information see also *18 Spacecraft Design, Testing and Performance*; and *20 Spacecraft Propulsion and Power*.

20030060423 Massachusetts Inst. of Tech., Cambridge, MA
Model Predictive Control for Terminal Area Energy Management and Approach and Landing for a Reusable Launch Vehicle
LePome, Robert C., II; Jun. 2002; 235 pp.; In English
Report No.(s): AD-A412300; MIT-CI02-808; No Copyright; Avail: CASI; A11, Hardcopy

The space industry plans to develop new reusable launch vehicles. The new vehicles will need advanced, new guidance and control systems. Since 1996 Draper Laboratory has been developing the next generation guidance and control for reusable launch vehicles in which guidance and control is integrated into one correlated system. Draper's research of integrated

guidance and control originated with a single loop multivariable control scheme using time-invariant linear quadratic regulator theory. The research has since evolved into the use of model predictive control theory. The main focus of this thesis is the theory and design of model predictive control for entry of aerospace vehicles. The goal is to develop design criteria and guidelines explaining how to select the model predictive control parameters: prediction horizon, simulation rates, and weighting matrices. A secondary goal is to tightly couple an onboard trajectory generation algorithm with the model predictive controller to improve tracking performance and robustness. Favorable tracking is achieved through two model predictive control architectures, which are discussed. The first architecture has an inner loop stability augmentation system with model predictive control used as an outer loop. The second architecture replaces the inner and outer loops with a single model predictive controller. The two architectures demonstrate the flexibility of model predictive control to adapt to new vehicles; the model predictive control may be used to augment an existing inner loop or may be used as a stand-alone controller. The design focuses primarily on the architecture without a stability augmentation system.
DTIC
Space Transportation; Launch Vehicles; Design Optimization

20030061142 NASA Kennedy Space Center, Cocoa Beach, FL, USA
STS-103 Photo-op/Suit-up/Depart O&C/Launch Discovery On-Orbit/Landing/Crew Egress
April 10, 2001; In English; No Copyright; Avail: CASI; V03, Videotape-VHS; B03, Videotape-Beta

The crew of the STS-103 space mission are shown as they prepare for launch and landing of the space shuttle discovery. The crew includes: Commander Curtis L. Brown, Pilot Scott J. Kelly, and Mission Specialists: Steven L. Smith, C. Michael Foale, John M. Grunsfeld, Claude Nicollier and Jean-francois Clervoy. Footage of these astronauts during suit-up, Ingress, Egress and Operations and Checkout (O&C) is presented. Live footage of the countdown and launch of the space shuttle discovery is shown from various vantage points such as the Tower 1, Vehicle Assembly Building (VAB), and pad perimeter. Once in orbit, a presentation of Steven Smith, John Grunsfield, Michael Foale and Claude Nicollier performing three spacewalks to repair the HST is shown. The landing of the space shuttle discovery at the Kenndy Space Center is shown.
CASI
Discovery (Orbiter); Space Transportation System; Egress; Extravehicular Activity; Space Missions; Spacecraft Launching

20030061180 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Hybrid Control Strategies for Rapid, Large Angle Satellite Slew Maneuvers
French, David B.; Mar. 2003; 135 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412869; AFIT/GA/ENY/03-2; No Copyright; Avail: CASI; A07, Hardcopy

This research investigated hybrid control strategies for rapid satellite pointing. First, a detailed computer simulation model of AFIT's SIMSAT satellite simulator was constructed. Control strategies were developed to enable the system to perform large-angle, 3-axis slewing maneuvers using a combination of both thrusters and reaction wheels. To handle the non-linear model, a State Dependent Riccati Equation controller was programmed and successfully controlled the computer-modeled satellite for any given slewing maneuver. A simpler PD controller was then programmed and demonstrated on the computer simulation of SIMSAT, using a combination of thruster and reaction wheel control inputs for large-angle single axis maneuvers and for small angles using three-axis control. There was good agreement between the experimentally obtained maneuver results and those produced with the computer simulation model for the single-axis case. Lastly, the trade-off between settling time and thruster fuel is discussed, as well as the variation of gains required to achieve maximum performance for a desired slew.
DTIC
Spacecraft Maneuvers; Computerized Simulation; Slewing; Artificial Satellites; Mathematical Models

20030061271 Air Force Research Lab., Edwards AFB, CA, USA
Progress in the Parallelization of the SOCRATES-P Missile Plume Code
Cambier, J.-L.; Smith, T.; Cline, J.; Braunstein, M.; Chakravarthy, S.; Mar. 3, 2003; 3 pp.; In English
Contract(s)/Grant(s): AF Proj. 2304
Report No.(s): AD-A412255; AFRL-PR-ED-AB-2003-052; No Copyright; Avail: CASI; A01, Hardcopy

Progress report in the implementation of a parallelized version of SOCRATES under HPCMP CHSSI Project CFD-10. Examples of the increased capabilities of the Pre-Alpha code are given along with an overview of the software design approach.
DTIC
Spacecraft Propulsion; Exhaust Gases; Plumes

16
SPACE TRANSPORTATION AND SAFETY

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques. For related information see also *03 Air Transportation and Safety; 15 Launch Vehicles and Launch Operations*; and *18 Spacecraft Design, Testing and Performance*. For space suits see *54 Man/System Technology and Life Support*.

20030059504 NASA Kennedy Space Center, Cocoa Beach, FL, USA
STS-110/Atlantic/ISS 8A Pre-Launch-Launch On Orbit-Landing-Crew Egress
April 19, 2002; In English; No Copyright; Avail: CASI; V04, Videotape-VHS; B04, Videotape-Beta

The crew of STS-110, which consists of Commander Michael Bloomfield, Pilot Stephen Frick, and Mission Specialists Rex Walheim, Ellen Ochoa, Lee Morin, Jerry Ross, and Steven Smith is introduced at the customary pre-flight meal. The narrator provides background information on the astronauts during suit-up. Each crew member is shown in the White Room before boarding Space Shuttle Atlantis, and some display signs to loved ones. Launch footage includes the following replays: Beach Tracker, VAB, Pad B, Tower 1, DLTR-3, Grandstand, Cocoa Beach DOAMS, Playalinda DOAMS, UCS-23, SLF Convoy, OTV-154, OTV-163, OTV-170 (mislabeled), and OTV-171 (mislabeled). After the launch, NASA administrator Sean O'Keefe gives a speech to the Launch Control Center, with political dignitaries present. While on-orbit, Atlantis docks with the International Space Station (ISS), and Canadarm 2 on the ISS lifts the S0 Truss out of the orbiter's payload bay. The video includes highlights of three extravehicular activities (EVAs). In the first, the S0 Truss is fastened to the Destiny Laboratory Module on the ISS. During the third EVA, Walheim and Smith assist in the checkout of the handcart on the S0 Truss. The Atlantis crew is shown gathered together with the Expedition 4 crew of the ISS, and again by itself after undocking. Replays of the landing include: VAB, Tower 1, Mid-field, Runway South End, Runway North End, Tower 2, Playalinda DOAMS, Cocoa Beach DOAMS, and Pilot Point of View (PPOV). After landing, Commander Bloomfield lets each of his crew members give a short speech.
Author
Atlantis (Orbiter); Spacecraft Launching; Horizontal Spacecraft Landing; Spacecrews; Spacecraft Docking; International Space Station; Extravehicular Activity; Orbital Assembly

20030060442 Federal Aviation Administration, Washington, DC, Fire Administration, Emmitsburg, MD, USA
Economic Impact of Commercial Space Transportation on the US Economy
Feb. 2001; 26 pp.; In English
Report No.(s): PB2003-104883; No Copyright; Avail: CASI; A03, Hardcopy

This report is the Federal Aviation Administration Associate Administrator for Commercial Space Transportation's (FAA/AST) first study of the U.S. commercial launch industry's effect on the nation's economy. This report is a quantitative analysis of the extent to which commercial space transportation is responsible directly and indirectly for supporting a variety of space and non-space-related industries, thereby contributing to production and generating jobs in the USA. Monies are generated in the U.S. economy from the manufacture and purchase of commercial launch vehicles as well as from the commercial space activities 'enabled' by the launch industry. This report examines the U.S. commercial launch vehicle industry and the enabled commercial space activities together, as both are needed to assess fully the impact of commercial space transportation on the U.S. economy. The industries analyzed include launch vehicle manufacturing; satellite and ground equipment manufacturing; satellite services; remote sensing; and distribution industries. The impacts quantified in this report are based on data for the year 1999.
NTIS
Aerospace Industry; Economic Impact; Space Transportation; Space Commercialization; Launch Vehicles

20030061159 NASA Marshall Space Flight Center, Huntsville, AL, USA
Systems Engineering Approach to Technology Integration for NASA's 2nd Generation Reusable Launch Vehicle
Thomas, Dale; Smith, Charles; Thomas, Leann; Kittredge, Sheryl; [2002]; 14 pp.; In English; Space Technology Applications International Forum, 2-6 Feb. 2003, Albuquerque, NM, USA; No Copyright; Avail: CASI; A03, Hardcopy

The overall goal of the 2nd Generation RLV Program is to substantially reduce technical and business risks associated with developing a new class of reusable launch vehicles. NASA's specific goals are to improve the safety of a 2nd generation system by 2 orders of magnitude - equivalent to a crew risk of 1-in-10,000 missions - and decrease the cost tenfold, to approximately $1,000 per pound of payload launched. Architecture definition is being conducted in parallel with the maturating of key technologies specifically identified to improve safety and reliability, while reducing operational costs. An architecture broadly includes an Earth-to-orbit reusable launch vehicle, on-orbit transfer vehicles and upper stages, mission

planning, ground and flight operations, and support infrastructure, both on the ground and in orbit. The systems engineering approach ensures that the technologies developed - such as lightweight structures, long-life rocket engines, reliable crew escape, and robust thermal protection systems - will synergistically integrate into the optimum vehicle. To best direct technology development decisions, analytical models are employed to accurately predict the benefits of each technology toward potential space transportation architectures as well as the risks associated with each technology. Rigorous systems analysis provides the foundation for assessing progress toward safety and cost goals. The systems engineering review process factors in comprehensive budget estimates, detailed project schedules, and business and performance plans, against the goals of safety, reliability, and cost, in addition to overall technical feasibility. This approach forms the basis for investment decisions in the 2nd Generation RLV Program's risk-reduction activities. Through this process, NASA will continually refine its specialized needs and identify where Defense and commercial requirements overlap those of civil missions.
Author
Reusable Launch Vehicles; Systems Engineering; Technology Assessment; Space Transportation; Safety Factors; Ground Operational Support System

18
SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and spacecraft control and stability characteristics. For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance; 39 Structural Mechanics*; and *16 Space Transportation and Safety*.

20030061154 NASA Marshall Space Flight Center, Huntsville, AL, USA
The Successful Development of an Automated Rendezvous and Capture (AR&C) System for the National Aeronautics and Space Administration
Roe, Fred D.; Howard, Richard T.; [2003]; 5 pp.; In English; STAIF-2003, 2-6 Feb. 2003, Albuquerque, NM, USA; No Copyright; Avail: CASI; A01, Hardcopy

During the 1990's, the Marshall Space Flight Center (MSFC) conducted pioneering research in the development of an automated rendezvous and capture/docking (AR&C) system for U.S. space vehicles. Development and demonstration of a rendezvous sensor was identified early in the AR&C Program as the critical enabling technology that allows automated proximity operations and docking. A first generation rendezvous sensor, the Video Guidance Sensor (VGS), was developed and successfully flown on STS-87 and STS-95, proving the concept of a video- based sensor. A ground demonstration of the entire system and software was successfully tested. Advances in both video and signal processing technologies and the lessons learned from the two successful flight experiments provided a baseline for the development, by the MSFC, of a new generation of video based rendezvous sensor. The Advanced Video Guidance Sensor (AGS) has greatly increased performance and additional capability for longer-range operation with a new target designed as a direct replacement for existing ISS hemispherical reflectors.
Author
NASA Programs; Space Transportation System; Spacecraft Guidance; Spacecraft Control; Automatic Control

20030061293 NASA Johnson Space Center, Houston, TX, USA
Biotechnology System Facility: Risk Mitigation on Mir
Gonda, Steve R., III; Galloway, Steve R.; June 2003; 91 pp.; In English
Report No.(s): NASA/TP-2003-210197; S-876; NAS 1.60:210197; No Copyright; Avail: CASI; A05, Hardcopy

NASA is working with its international partners to develop space vehicles and facilities that will give researchers the opportunity to conduct scientific investigations in space. As part of this activity, NASA's Biotechnology Cell Science Program (BCSP) at the Johnson Space Center (JSC) is developing a world-class biotechnology laboratory facility for the International Space Station (ISS). This report describes the BCSP, including the role of the BTS. We identify the purpose and objectives of the BTS and a detailed description of BTS facility design and operational concept, BTS facility and experiment-specific hardware, and scientific investigations conducted in the facility. We identify the objectives, methods, and results of risk mitigation investigations of the effects of microgravity and cosmic radiation on the BTS data acquisition and control system. These results may apply to many other space experiments that use commercial, terrestrial-based data acquisition technology. Another focal point is a description of the end-to-end process of integrating and operating biotechnology experiments on a variety of space vehicles. The identification of lessons learned that can be applied to future biotechnology experiments is an

overall theme of the report. We include a brief summary of the science results, but this is not the focus of the report. The report provides some discussion on the successful 130-day tissue engineering experiment performed in BTS on Mir and describes a seminal gene array investigation that identified a set of unique genes that are activated in space.
Author
Biotechnology; Risk; Spaceborne Experiments; Mir Space Station; Systems Engineering

20
SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources. For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 15 Launch Vehicles and Launch Operations*, and *44 Energy Production and Conversion*.

20030060417 Air Force Research Lab., Edwards AFB, CA, USA
Interactions Within a Cluster of Low Power Hall Thrusters
Hargus, W. A., Jr.; Jan. 30, 2003; 10 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A412295; AFRL-PR-ED-TP-2003-010; No Copyright; Avail: CASI; A02, Hardcopy

This work examines a long duration Hall thruster start transient caused by the vacuum chamber environment. During operation of a cluster of four Hall thrusters, large anode discharge fluctuations, visible as increased anode current and a more diffuse plume structure, occur in an apparently random manner. For single thrusters, the transient appears as a smoothly decaying elevated anode current with a diffuse plume which persists for less than 500 seconds. The start transient is characterized by severe 18 kHz oscillations which dominate the anode discharge. This contrasts with typical steady state behavior of a strong DC component overlaid with a low amplitude 25 kHz component. The main discharge chamber has been previously determined to be the source of this behavior. The work shows that transient appears to be a result of the release of water previously hydrated on to on the surface layer of the boron nitride acceleration channel insulator.
DTIC
Hall Effect; Vacuum Chambers; Thrustors

20030060446 Phillips Lab., Edwards AFB, CA
Dependence of Solar-Thermal Rocket Performance on Concentrator Performance
Holmes, Michael R.; Laug, Kristi K.; Jan. 1995; 14 pp.; In English
Report No.(s): AD-A412264; No Copyright; Avail: CASI; A03, Hardcopy

The Phillips Laboratory (OLAC) at Edwards Air Force Base is actively working to forward research and development in Solar-Thermal Propulsion. The concentrator support structure trade studies reviewed were the result of PRDA program Research and Development Announcement) contracts, for example. Recent funding is through SBIR (Small Business Innovative Research), however, as money for larger contracts becomes rare. Topics such as space concentrator development, thruster development, pointing and accuracy, etc. are of interest to the Phillips Laboratory Solar Products group. The purpose of this paper is to give a feeling for the concentrator performance level needed to make this propulsion concept useful. This paper introduces some basic propulsion concepts. This basic prerequisite is necessary to show how concentrator behavior affects the performance of a solar rocket. Some concentrator basics are also included. Upper-limits are defined for performance of the solar rocket and compared with conventional rocket designs. The most popular configuration for a solar powered rocket is described and discussed. The geometry and performance of a specific type of off-axis paraboloid is discussed. Finally, recent concentrator structure development is reviewed briefly.
DTIC
Spacecraft Propulsion; Concentrators; Spacecraft Performance; Solar Thermal Propulsion; Rocket Engine Design

20030060479 Air Force Research Lab., Edwards AFB, CA, USA
The USAF Electric Propulsion Program
Spores, Ronald A.; Birkan, Mitat; Jun. 24, 1999; 13 pp.; In English
Contract(s)/Grant(s): F04611-96-C-0023; Proj-3005
Report No.(s): AD-A411891; AFRL-PR-ED-TP-FY99-0155; AIAA 99-2162; No Copyright; Avail: CASI; A03, Hardcopy

An overview of the current electric propulsion technology development efforts within the USA Air Force is presented. The principal electric propulsion activity for 1999 is the successful flight of the Electric Space Experiment (ESEX), a 30 kilowatt

ammonia arcjet system. This program was the culmination of a 10 year development effort to validate high power electric propulsion on-orbit and verify its compatibility with Air Force satellites. Two groups within the Air Force Research Laboratory contribute to the electric propulsion program: Propulsion Directorate and Air Force Office of Scientific Research (AFOSR). The Propulsion Directorate conducts electric propulsion efforts in basic research, engineering development, and space experiments. AFOSR funds basic research in electric propulsion throughout the country in both academia and industry.
DTIC
Electric Propulsion; Aeronautical Engineering; Military Technology; Air Defense

20030060677 Air Force Research Lab., Edwards AFB, CA, USA
Overview of the USAF Electric Propulsion Program
Spores, Ronald A.; Spanjers, Gregory G.; Birkan, Mitat; Lawrence, Timothy J.; Jul. 11, 2001; 16 pp.; In English
Contract(s)/Grant(s): F04611-97-C-0064; Proj-4373
Report No.(s): AD-A412581; AFRL-PR-ED-TP-2001-155; No Copyright; Avail: CASI; A03, Hardcopy

An overview of current electric propulsion research and development efforts within the USA Air Force is presented. The Air Force supports electric propulsion primarily through the Air Force Office of Scientific Research (AFOSR) , the Air Force Research Laboratory (AFRL) and the AFOSR European Office of Aerospace Research and Development (EOARD). Overall direction for the programs comes from Air Force Space Command (AFSPC), with AFRL mission analysis used to define specific technological advances needed to meet AFSPC mission priorities.
DTIC
Electric Propulsion; Military Technology; Research And Development

20030060685 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Progress in Pulsed Detonation Rocket Engines at AFRL-West
Talley, Doug; Jan. 24, 2002; 12 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410766; AFRL-PR-ED-TP-2002-012; No Copyright; Avail: CASI; A03, Hardcopy

These viewgraphs present the topic of progress in pulsed detonation rocket engines. Space payoffs for PDREs are thus: previous estimates have shown potential lsp advantages at sea level and even up to significant attitudes. However, there appeared to be little or no lsp advantage in a vacuum. When practical considerations governing real nozzles are considered, there now appears to potentially be an lsp advantage.
DTIC
Pulse Detonation Engines; Propulsive Efficiency; Propulsion System Performance

20030060691 Atlantic Research Corp., Gainesville, VA
SPT-140 High Performance Hall System (HPHS) Development
Stuckey, P.; Clauss, C.; Day, M.; Murashko, V.; Maslennikov, N.; Jul. 10, 1998; 14 pp.; In English
Contract(s)/Grant(s): F04611-97-C-0064; Proj-4373
Report No.(s): AD-A410741; AFRL-PR-ED-TP-1998-141; No Copyright; Avail: CASI; A03, Hardcopy

The status of the Atlantic Research Corporation's Air Force Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Performance Hall System (HPHS) contract to develop a 4.5 kW Hall effect thruster system is presented. The SPT-140 system heritage is described, and the members of the HPHS SPT-140 team are introduced. The objective of the Air Force contract are presented, and the SPT-140 system that has been designed to meet those objectives is described. To meet the IHPRPT goals, the magnetic system has been redesigned to improve thruster efficiency and life requirements. This and other accomplishments in the design and qualification of the SPT-140 system are presented along with the future milestones for the contract. The HPHs SPT-140 system will provide government and commercial customers an ideal propulsion system for a wide variety of LEO, GEO, and exploratory missions.
DTIC
Hall Thrusters; Spacecraft Propulsion

20030061072 NASA Marshall Space Flight Center, Huntsville, AL, USA
MSFC MXER Tether Study
Polsgrove, Tara; Alexander, Reginald; Bonometti, Joseph; Chapman, Jack; Garza, Lucas; Glaese, John; Glasgow, Shaun; Guendel, Herb; Houston, Vance; Johnson, Paul, et al.; April 14, 2003; 14 pp.; In English; Advanced Space Propulsion Workshop, 15-17 Apr. 2003, Huntsville, AL, USA; No Copyright; Avail: CASI; A03, Hardcopy

This viewgraph presentation provides an overview of the proposed Momentum-eXchange/Electrodynamic Reboost (MXER) space hardware system. The tether system would be position cart-wheeling cables above the Earth and then, rotating like a giant sling, would capture spacecraft or payloads from space shuttles in low Earth orbits and launch them into higher orbits. This study focuses on system validation and structural design issues for MXER. Topics examined include: tether facility design, ED tether system, payload capture/catch mechanism, payload accomodations assembly (PAA), PAA rendezvous capability, and PAA capability to correct tether misthrows.
CASI
Tethering; Spacecraft Propulsion; Research And Development; Structural Design; Systems Engineering; Tetherlines

20030061081 Air Force Research Lab., Edwards AFB, CA, USA
Characterization of a Gas/Gas, Hydrogen/Oxygen Engine
Archambault, M. R.; Peroomian, O.; Jun. 4, 2002; 11 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410801; AFRL-PR-ED-TP-2002-136; No Copyright; Avail: CASI; A03, Hardcopy

As part of an ongoing program to develop a computational methodology to obtain high-fidelity rocket engine flow solutions, computations were performed on a single-element, gas/gas, H2/O2 combustion engine. The present work examines the influence of modeling experimental features often neglected in a simulation, specifically a nitrogen curtain purge used to cool optical access. It is shown that the influence is significant and better agreement with the data can be obtained by including the nitrogen purge. Additional solutions are presented to investigate the impact of using various turbulence models on this class of problems. A linear, realizable k-epsilon model best represented the experimental data, however, it should be recognized that RANS-type turbulence models are best suited to steady, isotropic flows, which the present flowfield is not.
DTIC
Nitrogen; Rocket Engines

20030061088 NASA Marshall Space Flight Center, Huntsville, AL, USA
Characterization of Space Environmental Effects on Candidate Solar Sail Material
Edwards, David; Hubbs, Whitney; Stanaland, Tesia; Altstatt, Richard; [2002]; 1 pp.; In English; Propulsion Engineering Research Center 14th Annual Symposium on Propulsion, 10-11 Dec. 2002, University Park, PA, USA; Copyright; Avail: CASI; A01, Hardcopy

The National Aeronautics and Space Administration's (NASA) Marshall Space Flight Center (MSFC) is concentrating research into the utilization of photonic materials for spacecraft propulsion. Spacecraft propulsion, using photonic materials, will be achieved using a solar sail. A sail operates on the principle that photons, originating from the sun, impart pressure and provide a source of spacecraft propulsion. The pressure can be increased, by a factor of two if the sun-facing surface is perfectly reflective. Solar sails are generally composed of a highly reflective metallic front layer, a thin polymeric substrate, and occasionally a highly emissive back surface. The Space Environmental Effects Team at MSFC is actively characterizing candidate solar sail materials to evaluate the thermo-optical and mechanical properties after exposure to a simulated Geosynchronous Transfer Orbit (GTO) radiation environment. The technique of radiation dose verses material depth profiling was used to determine the orbital equivalent exposure doses. The solar sail exposure procedures and results of the material characterization will be discussed.
Author
Spacecraft Propulsion; Photonic Propulsion; Solar Sails; Spacecraft Construction Materials

20030061098 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Analysis of Xenon Flow Calibration Techniques for Electric Thruster Testing
Kirtley, D. E.; Engelman, S. F.; Fife, J. M.; Jun. 18, 2002; 7 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410833; AFRL-PR-ED-TP-2002-154; No Copyright; Avail: CASI; A02, Hardcopy

In assessing the performance characteristics of Hall-effect thrusters (RETs) and ion engines, it is important to have an accurate estimate of the propellant flow rate to the engine. The difficulty lies in accurately measuring the very low flow rates, below 1 mg/s of xenon gas. Most test facilities use commercial calibration-certified mass flow controllers and meters. However, these flow meters drift over time from their calibration. Recalibration is typically an expensive and time consuming task which can only he performed at a few select locations; therefore it is desirable for an in-house calibration verification

system to be available to detect calibration drift. Here we examine the theory %of constant-volume calibration, and propose a cost effective constant-volume flow rate verification apparatus.
DTIC
Calibrating; Xenon; Hall Thrusters; Electric Propulsion

20030061099 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Effect of Propellant Temperature on Efficiency in the Pulsed Plasma Thruster
Spanjers, Gregory G.; Malak, Jamie B.; Leiweke, Robert S.; Spores, Ronald A.; Jan. 16, 2003; 11 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410891; AFRL-PR-ED-TP-2003-012; No Copyright; Avail: CASI; A03, Hardcopy

A pulsed plasma thruster (PPT) benefits from the inherent engineering simplicity-and reduced tankage fraction gained by storing the propellant as a solid. The solid is converted to the gaseous state and accelerated by an electric discharge across the propellant face. Previous research has concluded that as little as 10\% of the consumed propellant is converted to plasma and efficiently accelerated. The remaining propellant is consumed in the form of late-time vaporization and particulate emission, creating minimal thrust. Critical to improving the PPT performance is improving the propellant utilization. The present work demonstrates one possible method of increasing the PPT propellant efficiency. By measuring the PPT thrust, propellant consumption, and propellant temperature while varying the power level, duration of the experimental run, and total propellant mass, a correlation is established between decreased propellant temperature and increased propellant efficiency. The method is demonstrated by performance measurements at 60 W and S W, which show a 25\% increase in thrust efficiency, while the propellant temperature decreases from 135 to 42 deg C. Larger increases in the efficiency may be realized on-orbit where operating temperatures are commonly subzero. The dependence of propellant consumption on temperature also creates systematic errors in laboratory measurements with short experimental runs, and orbit analyses where the PPT performance measured at one power level is linearly scaled to the power available on the spacecraft.
DTIC
Pulsed Plasma Thrusters; Spacecraft Propulsion; Propellant Consumption; Temperature Effects; Power Efficiency

20030061138 Air Force Research Lab., Edwards AFB, CA, USA
Recent Developments in Liquid Rocket Injectors
Talley, Doug; Jun. 18, 2002; 61 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410764; AFRL-PR-ED-VG-2002-151; No Copyright; Avail: CASI; A04, Hardcopy

These viewgraphs discuss rocket injectors, major trends since the end of the Cold War, recent developments in rocket injector design tools, gas/gas injector development, and injection at supercritical pressures.
DTIC
Liquid Propellant Rocket Engines; Injectors

20030061151 Air Force Research Lab., Edwards AFB, CA, USA
Architecture and Initial Results of a 3-D Plasma Simulation System for Spacecraft-Thruster Interaction Assessment
Fife, J. M.; Gibbons, M. R.; VanGilder, D. B.; Kirtley, D. E.; Mar. 13, 2002; 10 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410835; AFRL-PR-ED-TP-2002-058; No Copyright; Avail: CASI; A02, Hardcopy

A 3-D Plasma Interaction Modeling System (PIMS) is being developed to predict the interaction of electric propulsion plumes with surfaces. The system is designed to be flexible, usable, and expandable, allowing users to define and mesh surfaces with their choice of off-the-shelf 3-D solid modeling packages. These surfaces are then loaded into PIMS, which performs plasma operations based on user commands. Functional PIMS modules will range from simple (prescribed plume field) to complex (full PIC-DSMC) depending on the user's request. PIMS will compute surface interaction parameters such as ion flux, ion energy, sputtering, and re-deposition. Development of PIMS to this date has progressed to include modules that a) import and superimpose prescribed plume distributions, and b) perform ray tracing of flux from point sources. This paper presents some of the first PIMS results -- sputtering predictions on a spacecraft and in a vacuum chamber due to a Hall-effect thruster.
DTIC
Architecture (Computers); Simulation; Plasma Engines; Thrustors; Spacecraft Propulsion

20030061161 Engineering Research and Consulting Inc (ERC INC) Edwards AFB CA, Edwards AFB, CA, USA
A Colloid Engine Accelerator Concept Update
Kirtley, D.; Fife, J. M.; Jan. 16, 2003; 10 pp.; In English
Contract(s)/Grant(s): F04611-99-C-0025; Proj-1011
Report No.(s): AD-A410870; AFRL-PR-ED-TP-2003-013; No Copyright; Avail: CASI; A02, Hardcopy

A concept for a colloid engine with an electrodynamic linear accelerator is described. The charged particle source is a standard colloid engine with an extractor voltage that has an AC component Downstream of the extractor, a series of accelerator gates are biased alternately with an AC voltage such that the charged droplets tend to remain in regions with positive electric fields. Since the droplet speed varies with their position in the accelerator, and the alternating voltage is of a constant frequency, the gate spacing must change with length. This variation in gate spacing may be determined analytically. This paper attempts to predict some of the potential performance advantages and disadvantages of such an engine through both mission analysis and first-order force analysis. In addition, the qualitative manufacturing and design performance sensitivities are investigated. Preliminary testing issues as well as higher level design ideas are explored, with special attention to potential problem areas.
DTIC
Electrodynamics; Spacecraft Propulsion; Linear Accelerators; Microrocket Engines; Pulsed Plasma Thrusters; Laser Ablation; Ion Engines

20030061171 Air Force Research Lab., Edwards AFB, CA, USA
Electric Propulsion Research at AFRL
Fife, John M.; May 21, 2001; 27 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410755; AFRL-PR-ED-VG-2001-108; No Copyright; Avail: CASI; A03, Hardcopy

These viewgraphs contain the following topics: Air Force electric propulsion research emphasis, micro-PPT technical approach, hall thrusters, high performance Hall system overview, risk reduction testing, technology transition, colloid thrusters, modelling and simulation of propulsion/spacecraft interaction, ground measurement needed for thruster emissions, spacecraft effects and basic physics, Hall thruster source modeling, and thruster interaction modeling and simulation.
DTIC
Electric Propulsion; Hall Effect; Research And Development; Thrust

20030061176 NASA Marshall Space Flight Center, Huntsville, AL, USA
Hydrostatic Stress Effect on the Yield Behavior of Inconel 100
Allen, Phillip A.; Wilson, Christopher D.; March 18, 2003; 38 pp.; In English; Memphis Area Engineering and Science Conference, 15 May 2003, Mephis, TN; Copyright; Avail: CASI

Classical metal plasticity theory assumes that hydrostatic stress has negligible effect on the yield and postyield behavior of metals. Recent reexaminations of classical theory have revealed a significant effect of hydrostatic stress on the yield behavior of various geometries. Fatigue tests and nonlinear finite element analyses (FEA) of Inconel 100 (IN100) equal-arm bend specimens and new monotonic tests and nonlinear finite element analyses of IN100 smooth tension, smooth compression, and double-edge notch tension (DENT) test specimens have revealed the effect of internal hydrostatic tensile stresses on yielding. Nonlinear FEA using the von Mises (yielding is independent of hydrostatic stress) and the Drucker-Prager (yielding is linearly dependent on hydrostatic stress) yield functions were performed. A new FEA constitutive model was developed that incorporates a pressure-dependent yield function with combined multilinear kinematic and multilinear isotropic hardening using the ABAQUS user subroutine (UMAT) utility. In all monotonic tensile test cases, the von Mises constitutive model, overestimated the load for a given displacement or strain. Considering the failure displacements or strains for the DENT specimen, the Drucker-Prager FEM s predicted loads that were approximately 3\% lower than the von Mises values. For the failure loads, the Drucker Prager FEM s predicted strains that were up to 35\% greater than the von Mises values. Both the Drucker-Prager model and the von Mises model performed equally-well in simulating the equal-arm bend fatigue test.
Author
Hydrostatics; Inconel (Trademark); Plastic Deformation; Yield Strength; Bend Tests; Fatigue Tests; Tensile Stress; Notch Tests

20030061179 NASA Marshall Space Flight Center, Huntsville, AL, USA
Engineering of the Magnetized Target Fusion Propulsion System
Statham, G.; White, S.; Adams, R. B.; Thio, Y. C. F.; Samtarius, J.; Alexander, R.; Chapman, J.; Fincher, S.; Philips, A.; Polsgrove, T.; [2002]; 24 pp.; In English; STAIF 2003 Meeting, 2-6 Feb. 2003, Albuquerque, NM, USA
Contract(s)/Grant(s): 713-50-10; Copyright; Avail: Other Sources

Engineering details are presented for a magnetized target fusion (MTF) propulsion system designed to support crewed missions to the outer solar system. Basic operation of an MTF propulsion system is introduced. Structural, thermal, radiation-management and electrical design details are presented. The propellant storage and supply system design is also presented. A propulsion system mass estimate and associated performance figures are given. The advantages of helium-3 as a fusion fuel for an advanced MTF system are discussed.
Author
Systems Engineering; Fusion Propulsion; Spacecraft Propulsion; Targets

20030061192 Air Force Research Lab., Edwards AFB, CA, USA
Status of the Air Force Solid Rocket Motor Insulation Program
Blanski, Rusty; Phillips, Shawn; Jul. 11, 2001; 27 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410885; AFRL-PR-ED-VG-2001-145; No Copyright; Avail: CASI; A03, Hardcopy
Viewgraphs for presentation given on the status of Air Force research and development of solid rocket engines insulation.
DTIC
Insulation; Solid Propellants

20030061199 NASA Marshall Space Flight Center, Huntsville, AL, USA
Solar Thermal Propulsion
Gerrish, Harold P., Jr.; [2003]; 34 pp.; In English; AIAA Space Propulsion Symposium, 15 Feb. 2003, Cocoa Beach, FL, USA; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy
This paper presents viewgraphs on Solar Thermal Propulsion (STP). Some of the topics include: 1) Ways to use Solar Energy for Propulsion; 2) Solar (fusion) Energy; 3) Operation in Orbit; 4) Propulsion Concepts; 5) Critical Equations; 6) Power Efficiency; 7) Major STP Projects; 8) Types of STP Engines; 9) Solar Thermal Propulsion Direct Gain Assembly; 10) Specific Impulse; 11) Thrust; 12) Temperature Distribution; 13) Pressure Loss; 14) Transient Startup; 15) Axial Heat Input; 16) Direct Gain Engine Design; 17) Direct Gain Engine Fabrication; 18) Solar Thermal Propulsion Direct Gain Components; 19) Solar Thermal Test Facility; and 20) Checkout Results.
CASI
Solar Energy; Solar Thermal Propulsion; Spacecraft Design; Test Facilities

20030061215 NASA Marshall Space Flight Center, Huntsville, AL, USA
Hardware Based Technology Assessment in Support of Near-Term Space Fission Missions
Houts, Mike; VanDyke, Melissa; Godfroy, Tom; Martin, James; BraggSitton, Shannon; Carter, Robert; Dickens, Ricky; Salvail, Pat; Williams, Eric; Harper, Roger, et al.; [2003]; 6 pp.; In English; STAIF 2003, 2-6 Feb. 2003, Albuquerque, NM, USA; Copyright; Avail: CASI; A02, Hardcopy
Fission technology can enable rapid, affordable access to any point in the solar system. If fission propulsion systems are to be developed to their full potential; however, near-term customers must be identified and initial fission systems successfully developed, launched, and utilized. Successful utilization will most likely occur if frequent, significant hardware-based milestones can be achieved throughout the program. Achieving these milestones will depend on the capability to perform highly realistic non-nuclear testing of nuclear systems. This paper discusses ongoing and potential research that could help achieve these milestones.
Author
Fission; Space Missions; Technology Assessment; Hardware; Nuclear Electric Propulsion

20030061231 NASA Marshall Space Flight Center, Huntsville, AL, USA
Direct-Drive Gas-Cooled Reactor Power System: Concept and Preliminary Testing
Wright, S. A.; Lipinski, R. J.; Godfroy, T. J.; Bragg-Sitton, S. M.; VanDyke, M. K.; [2002]; 6 pp.; In English; STAIF 2003, 2-6 Feb. 2003, Albuquerque, NM, USA; No Copyright; Avail: CASI; A02, Hardcopy
This paper describes the concept and preliminary component testing of a gas-cooled, UN-fueled, pin-type reactor which uses He/Xe gas that goes directly into a recuperated Brayton system to produce electricity for nuclear electric propulsion. This Direct-Drive Gas-Cooled Reactor (DDG) is designed to be subcritical under water or wet- sand immersion in case of a launch accident. Because the gas-cooled reactor can directly drive the Brayton turbomachinery, it is possible to configure the system such that there are no external surfaces or pressure boundaries that are refractory metal, even though the gas delivered to the

turbine is 1144 K. The He/Xe gas mixture is a good heat transport medium when flowing, and a good insulator when stagnant. Judicious use of stagnant cavities as insulating regions allows transport of the 1144-K gas while keeping all external surfaces below 900 K. At this temperature super-alloys (Hastelloy or Inconel) can be used instead of refractory metals. Super-alloys reduce the technology risk because they are easier to fabricate than refractory metals, we have a much more extensive knowledge base on their characteristics, and, because they have a greater resistance to oxidation, system testing is eased. The system is also relatively simple in its design: no additional coolant pumps, heat exchanger, or freeze-thaw systems are required. Key to success of this concept is a good knowledge of the heat transfer between the fuel pins and the gas, as well as the pressure drop through the system. This paper describes preliminary testing to obtain this key information, as well as experience in demonstrating electrically heated testing of simulated reactor components.
Author
Gas Cooled Reactors; Fabrication; Systems Engineering; Gas Mixtures; Heat Resistant Alloys; Power Efficiency; Performance Tests

20030061233 NASA Marshall Space Flight Center, Huntsville, AL, USA
First Results of the Gasdynamic Mirror Fusion Propulsion Experiment
Emrich, William J., Jr.; [2002]; 7 pp.; In English; STAIF 2003, 2-6 Feb. 2003, Albuquerque, NM, USA; No Copyright; Avail: CASI; A02, Hardcopy

An experimental Gasdynamic Mirror or GDM device has been constructed at the NASA Marshall Space Flight Center to provide an initial assessment of the applicability of this technology for propulsion systems. This paper presents the first experimental results obtained from the machine and an analysis of the types of plasma instabilities likely to be encountered. It is intended that this device operate at higher plasma densities and with much larger L/D ratios than previous mirror machines. The high L/D ratio minimizes to a large extent certain magnetic curvature effects which lead to plasma instabilities causing a loss of plasma confinement. The high plasma density results in the plasma behaving much more like a conventional fluid with a mean free path shorter than the length of the device. This characteristic helps reduce problems associated with 'loss cone' microinstabilities. The device has been constructed to allow a considerable degree of flexibility in its configuration thus permitting the experiment to grow over time without necessitating a great deal of additional fabrication.
Author
Mirror Fusion; Gas Dynamics; Fusion Propulsion; Mechanical Devices

20030061234 NASA Marshall Space Flight Center, Huntsville, AL, USA
Test Facilities in Support of High Power Electric Propulsion Systems
VanDyke, Melissa; Houts, Mike; Godfroy, Thomas; Dickens, Ricky; Martin, James J.; Salvail, Patrick; Carter, Robert; [2002]; 6 pp.; In English; STAIF 2003, 2-6 Feb. 2003, Albuquerque, NM, USA; No Copyright; Avail: CASI; A02, Hardcopy

Successful development of space fission systems requires an extensive program of affordable and realistic testing. In addition to tests related to design/development of the fission system, realistic testing of the actual flight unit must also be performed. If the system is designed to operate within established radiation damage and fuel burn up limits while simultaneously being designed to allow close simulation of heat from fission using resistance heaters, high confidence in fission system performance and lifetime can be attained through non-nuclear testing. Through demonstration of systems concepts (designed by DOE National Laboratories) in relevant environments, this philosophy has been demonstrated through hardware testing in the High Power Propulsion Thermal Simulator (HPPTS). The HPPTS is designed to enable very realistic non-nuclear testing of space fission systems. Ongoing research at the HPPTS is geared towards facilitating research, development, system integration, and system utilization via cooperative efforts with DOE labs, industry, universities, and other NASA centers. Through hardware based design and testing, the HPPTS investigates High Power Electric Propulsion (HPEP) component, subsystem, and integrated system design and performance.
Author
Test Facilities; Fission; Spacecraft Propulsion; Systems Simulation; Nuclear Electric Propulsion; Performance Tests

20030061240 Air Force Research Lab., Edwards AFB, CA, USA
Pulse Combustion Rockets for Space Propulsion Applications
Coy, Edward B.; Dec. 20, 2002; 13 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A410861; AFRL-PR-ED-TP-2002-321; No Copyright; Avail: CASI; A03, Hardcopy

Pulse combustion propulsion devices are currently being considered as alternatives to conventional constant-pressure

engines. Potential advantages include reduction or elimination of pumps and/or compressors, and improved Isp for a given feed system supply pressure. In this paper a model is presented for a monopropellant-fueled, constant-volume, pulse combustor which includes finite-rate processes. A zero-dimensional model is used for the combustion chamber and a one-dimensional, quasi-steady approximation is used for the nozzle flow. The liquid spray is assumed to have a log-normal distribution of spherical droplets and the reaction rate is based on a strand burner correlation. This model was developed as a tool for designing an experimental rocket. In this paper it is used to explore the time and dimensional scales of the problem and to predict the performance and optimal geometry. The pulsed propulsion device is found to have nearly identical specific impulse as the steady-state engine operating with the same mass flow and throat area, furthermore, the nozzle optimizes at the same area ratio. Pulsed combustor behavior is found to depend on two time scales: the ratio of the heat release time to the chamber blow- down time, and the ratio of the blow-down time to the injector pulsing period. Finally, the model is used to assess potential benefits of pulsed engines for satellite applications. We briefly consider the application of pulse combustion devices in pressure-fed satellite propulsion systems and examine the effect on satellite mission.
DTIC
Spacecraft Propulsion; Pulse Generators; Combustion Chambers; Rocket Engine Design

20030061244 Air Force Research Lab., Edwards AFB, CA, USA
Initial Use of a 3-D Plasma Simulation System for Predicting Surface Sputtering and Contamination by Hall Thrusters
Fife, J. M.; Gibbons, M. R.; VanGilder, D. B.; Kirtley, D. E.; May 2002; 9 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410869; AFRL-PR-ED-TP-2002-106; No Copyright; Avail: CASI; A02, Hardcopy

A 3-D Plasma Interaction Modeling System is being developed to predict the interaction of electric propulsion plumes with surfaces. The system, named COLISEUM, is designed to be flexible, usable, and expandable, allowing users to define surfaces with their choice of off-the-shelf 3-D solid modeling packages. These surfaces are then loaded into COLISEUM, which performs plasma operations based on user commands. Functional modules are interchangeable, and can range from simple (prescribed plume field) to complex (PIC-DSMC). Surface interaction parameters such as ion flux, ion energy, sputtering, and re-deposition are computed. Development to date has progressed to include the two simplest functional modules: prescribed_plume, which imports and superimposes a plume distribution, and ray, which performs ray tracing of flux from point sources. More sophisticated functional plasma simulation modules such as PIC-Hybrid-MCC are currently being integrated. This paper presents some of the first COLISEUM results--sputtering and re-deposition predictions on a spacecraft and in a vacuum chamber due to operation of Hall-effect thrusters.
DTIC
Computerized Simulation; Hall Thrusters; Computer Programs

20030061248 Air Force Research Lab., Edwards AFB, CA, USA
Energy Conversion in Laser Propulsion II
Larson, C. W.; Mead, Franklin B., Jr.; Kalliomaa, Wayne M.; Dec. 26, 2001; 22 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410873; AFRL/PRS-ED-TP-2001-247; No Copyright; Avail: CASI; A03, Hardcopy

This paper reports on an analysis of overall energy conversion in laser propulsion. Experimental studies of a laboratory-scale propulsion device that absorbs laser energy and converts that energy to propellant kinetic energy were carried out. The Myrabo Laser Lightcraft (MLL), propelled by laser-heated air, was studied. The MLL incorporates an inverted parabolic reflector that focuses laser energy into a toroidal volume where it is absorbed by a unit of propellant mass that is subsequently expanded in the geometry of the plug nozzle aerospike. Thermodynamics predicted that the upper limit of the efficiency of conversion of the internal energy of laser heated air to jet kinetic energy, alpha, is approx. 0. 30 for EQUILIBRIUM expansion to 1 bar pressure. The analysis captures the equation of state of partially ionized air under conditions of chemical equilibrium. This upper limit alpha is nearly independent of the specific internal energy between 1 and 100 MJ/kilograms, or temperature from 2000 to 24000 K at a density of 1.18 kilograms/cu m. The upper-limit efficiency for optimum FROZEN expansion of laser-heated air is alpha = 0.27. With heating of air at its Mach 5 stagnation density (5.9 kilograms/cu m as compared to Standard Temperature and Pressure (STP) air density of 1.18 kilograms/cu m) these efficiencies increase to about 0.55 (equilibrium) and 0.45 (frozen). Optimum blowdown from 1.18 kilograms/cu m to 1 bar occurs with expansion ratios from approx. 1.5 to 4 as internal energy decreases from 1 to 100 MJ/kilograms. Heating of Mach 5 air at stagnation density requires larger expansion ratios, approx. 8 to 32, for optimum expansion to 1 bar. Expansion of laser-ablated Delrin propellant appears to convert the absorbed laser energy more efficiently to jet kinetic energy because the

effective density of the ablated gaseous Delrin is significantly greater than that of STP air.
DTIC
Laser Applications; Energy Conversion; Kinetic Energy; Carbon Dioxide Lasers; Solid Rocket Propellants; Laser Propulsion; Laser Heating

20030061294 Air Force Research Lab., Edwards AFB, CA, USA
Free Molecule Micro-Resistojet: Current Status
Ketsdever, Andrew; May 6, 2002; 36 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A410938; AFRL-PR-ED-VG-2002-096; No Copyright; Avail: CASI; A03, Hardcopy
No abstract available
DTIC
Microrocket Engines; Free Molecular Flow; Low Earth Orbits; Energy Consumption

20030061324 Air Force Research Lab., Edwards AFB, CA, USA
Modeling, Simulation, and Design of an Electrostatic Colloid Thruster
Kirtley, David; Fife, J. M.; May 17, 2002; 13 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410831; AFRL-PR-ED-VG-2002-114; No Copyright; Avail: CASI; A03, Hardcopy
Presented in this report is a modeling design process for a colloid micro-thruster. Topics discussed are acceleration grid effects, extractor grid effects and performance prediction and optimization.
DTIC
Colloidal Propellants; Electrostatics; Microrocket Engines; Engine Design

20030061348 NASA, Washington, DC, USA, NASA Marshall Space Flight Center, Huntsville, AL, USA
In-Space Propulsion Program Overview and Status
Wercinski, Paul F.; Johnson, Les; Baggett, Randy M.; [2003]; 1 pp.; In English; International Electric Propulsion Conference 2003, 17-21 Mar. 2003, Toulouse, France; No Copyright; Avail: Other Sources; Abstract Only
NASA's In-Space Propulsion (ISP) Program is designed to develop advanced propulsion technologies that can enable or greatly enhance near and mid-term NASA science missions by significantly reducing cost, mass, and/or travel times. These technologies include: Solar Electric Propulsion, Aerocapture, Solar Sails, Momentum Exchange Tethers, Plasma Sails and other technologies such as Advanced Chemical Propulsion. The ISP Program intends to develop cost-effective propulsion technologies that will provide a broad spectrum of mission possibilities, enabling NASA to send vehicles on longer, more useful voyages and in many cases to destinations that were previously unreachable using conventional means. The ISP approach to identifying and prioritizing these most promising technologies is to use mission and system analysis and subsequent peer review. The ISP program seeks to develop technologies under consideration to Technology Readiness Level (TRL) -6 for incorporation into mission planning within 3-5 years of initiation. The NASA TRL 6 represents a level where a technology is ready for system level demonstration in a relevant environment, usually a space environment. In addition, maximum use of open competition is encouraged to seek optimum solutions under ISP. Several NASA Research Announcements (NRA's) have been released asking industry, academia and other organizations to propose propulsion technologies designed to improve our ability to conduct scientific study of the outer planets and beyond. The ISP Program is managed by NASA Headquarters Office of Space Science and implemented by the Marshall Space Flight Center in Huntsville, Alabama.
Author
NASA Programs; Research And Development; Spacecraft Propulsion

20030061362 Massachusetts Inst. of Tech Cambridge MA Dept. of Aeronautics/Astronautics, Cambridge, MA, USA
Electric Micropropulsion
Martinez-Sanchez, Manuel; Jan. 8, 2003; 6 pp.; In English
Contract(s)/Grant(s): F49620-99-1-0076
Report No.(s): AD-A411187; SSL-5-01; AFRL-SR-AR-TR-03-0042; No Copyright; Avail: CASI; A02, Hardcopy
We report here results obtained from our research in two areas: fully kinetic modeling of the plasma in Hall thrusters, and

fluid modeling plus time-of-flight experiments on cone-jet colloid emitters for micropropulsion.
DTIC
Microthrust; Low Thrust Propulsion; Electric Propulsion; Propulsion System Performance

20030061383 Thiokol Propulsion, Brigham City, UT, USA
Overview of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program
Blair, M.; DeGeorge, D.; Oct. 6, 2000; 12 pp.; In English
Contract(s)/Grant(s): F04611-97-C-0033; Proj-1011
Report No.(s): AD-A411290; IAF-00-S.3.07; AFRL-PR-ED-TP-2000-186; No Copyright; Avail: CASI; A03, Hardcopy

The Integrated High Payoff Rocket Propulsion Technology Program (IHPRPT) is a structured Government and Industry program to improve U.S. rocket propulsion systems. The program is technology driven, goal oriented, and application focused. Integration of the technologies developed by the IHPRPT program is accomplished through key demonstrations. These demonstrators are used to verify compliance with goals. The achievement of the IHPRPT goals and the transition to operational systems provide significant payoff as well as a high return on investment. The IHPRPT program is being conducted as a fully coordinated, but not joint, effort. Each agency and Department of Defense component is responsible for funding and managing their respective portions of the effort. The effort is headed by the IHPRPT Steering Committee, which has representatives from each participating agency and service. Industry plays an active role in the program through an involvement in planning, participation at Steering Committee meetings, conducting of technology programs, identification of commercial transition opportunities, advocacy of the program, and teaming.
DTIC
Solid Propellant Rocket Engines; Research Projects

20030061427 NASA Marshall Space Flight Center, Huntsville, AL, USA
Momentum and Heat Flux Measurements in the Exhaust of VASIMR Using Helium Propellant
Chavers, D. Gregory; [2002]; 1 pp.; In English; International Electric Propulsion Conference, 17-21 Mar. 2003, Toulouse, France; No Copyright; Avail: Other Sources; Abstract Only

Electromagnetic thrusters typically use electric and magnetic fields to accelerate and exhaust plasma through interactions with the charged particles in the plasma. The energy required to create the plasma, i.e. ionization energy, is potential energy between the electron and ion. This potential energy is typically lost since it is not recovered as the plasma is exhausted and is known as frozen flow loss. If the frozen flow energy is a small fraction of the total plasma energy, this frozen flow loss may be negligible. However, if the frozen flow energy is a major fraction of the total plasma energy, this loss can severely reduce the energy efficiency of the thruster. Recovery and utilization of this frozen flow energy can improve the energy efficiency of a thruster during low specific impulse operating regimes when the ionization energy is a large fraction of the total plasma energy. This paper quantifies the recovery of the frozen flow energy, i.e. recombination energy, via the process of surface recombination for helium. To accomplish this task the momentum flux and heat flux of the plasma flow were measured and compared to calculated values from electrostatic probe data. This information was used to deduce the contribution of recombination energy to the total heat flux on a flat plate as well as to characterize the plasma conditions. Helium propellant was investigated initially due to its high ionization potential and hence available recombination energy.
Author
Thrustors; Electromagnetic Propulsion; Momentum; Heat Flux; Helium

23
CHEMISTRY AND MATERIALS (GENERAL)

Includes general research topics related to the composition, properties, structure, and use of chemical compounds and materials as they relate to aircraft, launch vehicles, and spacecraft. For specific topics in chemistry and materials see *categories 25 through 29*. For astrochemistry see category *90 Astrophysics*.

20030060494 NASA Marshall Space Flight Center, Huntsville, AL, USA
2002 Microgravity Materials Science Conference
Gillies, Donald, Editor; Ramachandran, Narayanan, Editor; Murphy, Karen, Editor; McCauley, Dannah, Editor; Bennett, Nancy, Editor; February 2003; 757 pp.; In English; 2002 Microgravity Materials Science Conference, 25-26 Jun. 2002, Huntsville, AL, USA; See also 20030060495 - 20030060592; Original contains color and black and white illustrations
Report No.(s): NASA/CP-2003-212339; M-1067; NAS 1.55:212339; No Copyright; Avail: CASI; A99, Hardcopy

The 2002 Microgravity Materials Science Conference was held June 25-26, 2002, at the Von Braun Center, Huntsville, Alabama. Organized by the Microgravity Materials Science Discipline Working Group, sponsored by the Physical Sciences Research Division, NASA Headquarters, and hosted by NASA Marshall Space Flight Center and member institutions under the Cooperative Research in Biology and Materials Science (CORBAMS) agreement, the conference provided a forum to review the current research and activities in materials science, discuss the envisioned long-term goals, highlight new crosscutting research areas of particular interest to the Physical Sciences Research Division, and inform the materials science community of research opportunities in reduced gravity. An abstracts book was published and distributed at the conference to the approximately 240 people attending, who represented industry, academia, and other NASA Centers. This CD-ROM proceedings is comprised of the research reports submitted by the Principal Investigators in the Microgravity Materials Science program.
Author
Conferences; Gravitational Effects; Crystal Growth; Directional Solidification (Crystals); Materials Science; Microgravity Applications; Space Processing

20030060513 Harvard Univ., MA, USA
Undercooling of Ferromagnetic Melts
Holland-Moritz, D.; Spaepen, F.; Aziz, M. J.; Herlach, D. M.; 2002 Microgravity Materials Science Conference; February 2003, pp. 575; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

We have studied the undercooling of Pd-Co melts below their ferromagnetic Curie points. We have developed a model for including the magnetic contribution to the energy of formation of the alloy crystal nucleus from a liquid alloy of a different composition. The results are in good agreement with the measured composition dependence of the maximum attainable undercooling.
Author
Palladium; Cobalt; Crystals; Melts (Crystal Growth); Liquid Alloys; Supercooling

20030060537 Ohio State Univ., Columbus, OH, USA
Fundamental Studies of Crystal Growth of Microporous Materials
Singh, Ramsharan; Doolittle, John, Jr.; Payra, Pramatha; Dutta, Prabir K.; George, Michael A.; Ramachandran, Narayanan; Schoeman, Brian J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 198-209; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

Microporous materials are framework structures with well-defined porosity, often of molecular dimensions. Zeolites contain aluminum and silicon atoms in their framework and are the most extensively studied amongst all microporous materials. Framework structures with P, Ga, Fe, Co, Zn, B, Ti and a host of other elements have also been made. Typical synthesis of microporous materials involve mixing the framework elements (or compounds, thereof) in a basic solution, followed by aging in some cases and then heating at elevated temperatures. This process is termed hydrothermal synthesis, and involves complex chemical and physical changes. Because of a limited understanding of this process, most synthesis advancements happen by a trial and error approach. There is considerable interest in understanding the synthesis process at a molecular level with the expectation that eventually new framework structures will be built by design. The basic issues in the microporous materials crystallization process include: (a) Nature of the molecular units responsible for the crystal nuclei formation; (b) Nature of the nuclei and nucleation process; (c) Growth process of the nuclei into crystal; (d) Morphological control and size of the resulting crystal; (e) Surface structure of the resulting crystals; and (f) Transformation of frameworks into other frameworks or condensed structures.
Derived from text
Crystal Growth; Porous Materials; Crystallization; Synthesis (Chemistry); Microporosity; Zeolites

20030060566 Rensselaer Polytechnic Inst., Troy, NY, USA
RIDGE/IDGE: A Successful Dendritic Growth Experiment
Lupulescu, Afma; Glicksman, M. E.; Giummara, C.; Koss, Matthew B.; LaCombe, J. C.; 2002 Microgravity Materials Science Conference; February 2003, pp. 254-267; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

Dendrites (tree-like crystals) represent highly evolved microstructures arising from unstable solid-melt interfaces. In fact, dendrites are the ubiquitous form of crystal growth encountered whenever metals and alloys solidify freely from supercooled

melts, or solidify directionally under low thermal gradients. The Isothermal Dendritic Growth Experiment, or IDGE, is a basic science experiment designed to provide terrestrial and microgravity data that measure the kinetics and morphology of dendritic solidification under pure heat conduction control. The IDGE flew three times as a primary payload on the USMP-2, -3, and -4 missions, in 1994, 1996, and 1997, respectively, aboard the US Space Shuttle Columbia. These flight experiments provided the first solid evidence that Ivantsov's heat conduction solution closely describes dendritic growth for the test materials succinonitrile (SCN) and pivalic acid (PVA). These organic crystals, offer three major experimental advantages compared to metals: they are transparent, easily purified to high levels, and have conveniently low melting points. The on-board IDGE instruments provided CCD images (telemetered to Earth during the flights), NASA-processed 35-mm film negatives (available postflight), and for the first time on USMP-4, near-real-time streaming of video data telemetered to our laboratory via the K-band (high-frequency) antenna on the shuttle. IDGE data in its totality, as reported elsewhere, consisted of hundreds of repeated experiments on steady-state dendritic growth. These data provide benchmark quality crystal growth speed as well as tip radii measured as functions of the melt supercooling,(Delta)T. The RIDGE program is designed as a follow-on to an ongoing MRD flight program, to frame the case that continuing ground-based data reduction and analysis will greatly enhance the understanding of existing or potential flight experiments in materials science.
Author
Dendritic Crystals; Spaceborne Experiments; Crystal Growth; Microgravity; Conductive Heat Transfer

20030060590 Northwestern Univ., Evanston, IL, USA
Coarsening in Solid-liquid Mixtures 2: A Comparison between Theory and Experiment
Rowenhorst, D. J.; Alkemper, J.; Snyder, V.; Voorhees, P. W.; 2002 Microgravity Materials Science Conference; February 2003, pp. 666-670; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A01, Hardcopy

Ostwald ripening occurs in multi-phase materials and is a diffusional process by which a system lowers its total energy by reducing the total interfacial area. In a two-phase system, large particles grow at the expense of smaller particles. As the system coarsens, the average particle size increases, while the total volume fraction of particles remains constant. Thus, there is a reduction in the average particle density within the system. Ostwald Ripening occurs in many two-phase mixtures, including precipitate hardened alloys, and can significantly affect the materials properties. For example, as coarsening progresses, the decreased particle density leads to a degradation of the mechanical strength of precipitation hardened alloys. Until recently there was little agreement between coarsening experiments and coarsening theory. The main difficulty in comparing theory to experiment is selecting a materials system that meets the criteria of the theory: mass transport that is diffusion controlled, low volume fraction of particles, an isotropic interfacial energy (spherical particles) and a stress-free matrix. In addition, for a practical experiment, the diffusion rate should be sufficient so that a large change in particle radius can be measured in a reasonable amount of time. Meeting all these requirements, especially the interfacial energy and stress free matrix requirements, in two-phase solid mixture becomes very difficult. Thus, we look to solid-liquid systems. The solid-liquid system that has been identified as an ideal system to test theory is a mixtures of Sn particles in a Pb-Sn eutectic matrix. This system meets all of the necessary requirements, and a large change in particle radius can be achieved over a relatively short time. In addition, all the physical parameters needed for comparison to theory are known. However, the density difference between the solid and liquid leads to a high degree of particle sedimentation. These experiments were performed with a high volume fraction of coarsening phase, which limits particle sedimentation, but also leads to a high number of particle contacts in the system, for which the theories do not account.
Author
Ostwald Ripening; Coarseness; Surface Properties; Binary Systems (Materials); Interfacial Energy; Liquid-Solid Interfaces

20030060696 Delaware Univ., Newark, DE
Organic-Inorganic Interactions in Hydrothermal Processing
Brill, Thomas B.; Oct. 26, 2002; 6 pp.; In English
Contract(s)/Grant(s): DAAG55-98-1-0253
Report No.(s): AD-A412728; ARO-38677.4-CH; No Copyright; Avail: CASI; A02, Hardcopy

The effect of inorganic species alone and on organic reactions at hydrothermal conditions was being investigated. The method involves the use of real-time IR spectroscopy in a windowed flow reactor. The specific studies were directed at the water gas shift reaction below the critical temperature of water; the kinetics of decomposition of nickel tetracarbonyl, sodium tetracarbonylcobaltate, and cyclopentadienyl cobalt dicarbonyl at hydrothermal conditions; decarboxylation and defluorination

of trifluoroacetate and fluoroform; and the decomposition of an organoazide and sodium azide at hydrothermal conditions. DTIC

Kinetics; Carboxylic Acids; Carbonyl Compounds

20030061164 Army Construction Engineering Research Lab., Champaign, IL, USA

Technology Demonstration of Nontoxic Chemical Stripper for Steel: Cost and Performance Report

Appleman, Bernard; Nau, Patrick; Jan. 2003; 76 pp.; In English

Report No.(s): AD-A412670; ERDC/CERL-CR-03-1; No Copyright; Avail: CASI; A05, Hardcopy

The environmental problem being addressed in this technology demonstration is the removal of lead-based paint (LBP) from steel structures without producing hazardous air pollutants. Environmentally acceptable chemical stripper technology was validated as part of a standard methodology for removing LBP on large steel structures owned by the Army, such as water tanks, aircraft hangars, bridges, antennas, ladders, poles, railings, and fuel storage tanks, leaving a surface suitable for repainting. In addition, this technology was demonstrated to meet environmental regulations and worker health and safety issues. Cost and performance data were collected and analyzed.

DTIC

Paints; Lead (Metal); Paint Removal

20030061197 Universal Energy Systems, Inc., Dayton, OH, USA

Crystallization Kinetics of an Amorphous TiAl Sheet Produced by PVD

Senkov, O. N.; Uchic, M. D.; Menon, S.; Miracle, D. B.; Feb. 2002; 8 pp.; In English

Contract(s)/Grant(s): F33615-01-C-5214; Proj-2306

Report No.(s): AD-A412867; AFRL-ML-WP-TP-2003-416; No Copyright; Avail: CASI; A02, Hardcopy

An amorphous, ISO micrometers thick freestanding sheet of a TiAl-based alloy was produced by a physical vapor deposition method. The following phase transformations were observed and analyzed using differential thermal analysis and X-ray diffraction, amorphous body centered cubic beta hexagonal close-packed alpha tetragonal gamma + ordered HCP alpha(sub 2).

DTIC

Amorphous Materials; Crystallization; Kinetics; Vapor Deposition; Titanium Aluminides

20030061198 NASA Marshall Space Flight Center, Huntsville, AL, USA

Characterization of Candidate Solar Sail Materials Subjected to Electron Radiation

Edwards, David; Gray, Perry; Nehis, Mary; Wertz, George; Hubbs, Whitney; Hoppe, David; Stanaland, Tesia; Hollerman, Andy; [2003]; 2 pp.; In English; Advanced Space Propulsion Workshop, 15-17 Apr. 2003, Huntsville, AL, USA; Copyright; Avail: Other Sources; Abstract Only

The concept of using photon pressure for propulsion has been considered since Tsiolkovsky in 1921. In fact, Tsiolkovsky and Tsander wrote of 'using tremendous mirrors of very thin sheets' and 'using the pressure of sunlight to attain cosmic velocities' in 1924. The term 'solar sailing' was coined in the late 1950s and was popularized by Arthur C. Clarke in the short story Sunjammer (The Wind From the Sun) in May 1964. The National Aeronautics and Space Administration (NASA) used sailing techniques to extend the operational life of the Mariner 10 spacecraft in 1974-1975. A problem in the control system was causing Mariner 10 to go off course. By controlling the attitude of Mariner 10 and the angle of the solar power panels relative to the Sun, ground controllers were able to correct the problem without using precious fuel. Solar sailing is a unique form of propulsion where a spacecraft gains momentum from incident photons. Solar sails are not limited by reaction mass and provide continual acceleration, reduced only by the lifetime of the lightweight film in the space environment and the distance to the Sun. Once thought to be difficult or impossible, solar sailing has come out of science fiction and into the realm of possibility. Any spacecraft using this method would need to deploy a thin sail that could be as large as many kilometers in extent. The availability of strong, ultra lightweight, and radiation resistant materials will determine the future of solar sailing. The National Aeronautics and Space Administration's Marshall Space Flight Center (MSFC) is concentrating research into the utilization of ultra lightweight materials for spacecraft propulsion. The Space Environmental Effects Team at MSFC is actively characterizing candidate solar sail material to evaluate the thermo-optical and mechanical properties after exposure to electron radiation. Practical sails must be resistant to the effects of long duration electron exposure. For this reason, research was initiated using a 50 keV electron source to determine the hardness of several candidate sail materials. Hardness in this context is defined as the amount of electron fluence (electrons/area) required to cause the sail material to fail. Solar sails are generally composed of a highly reflective metallic front layer, a thin polymeric substrate, and occasionally a highly emissive

back surface. State-of-the-art candidate solar sail materials are generally composed of a polymeric substrate that is 2 to 3 microns thick. This polymeric film is coated with a thin metallic layer, usually aluminum. A typical thickness for this metallic layer is 50 nm. Candidate solar sail materials, aluminized Mylar(trademark), aluminized Uplex and aluminized Kapton(trademark) are being characterized under this test plan. A radiation dose versus material depth profile was generated for each candidate sail material. This dose-depth profile was used to determine the relationship between the 50 keV electron fluence and radiation dose in the sail material. The focus of this investigation was to determine the effect of a uniform dose of 50 keV electron radiation on the sail material mechanical properties. Candidate sail materials were loaded, in tension, and exposed to electron radiation. The radiation dose levels, at material failure, were recorded and will be shown as a function of engineering stress. This paper will discuss the preliminary results of this research.
Author
Solar Sails; Materials Selection; Spacecraft Construction Materials; Radiation Effects; Electron Radiation; Failure Analysis; Fatigue Life

20030061256 Air Force Research Lab., Edwards AFB, CA, USA
Simulations of Energetic Materials for Rocket Propulsion: Obtaining More 'Bang for the Buck'
Sorescu, Dan C.; Thompson, Donald L.; Boatz, Jerry; Apr. 29, 2002; 5 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410827; AFRL-PR-ED-TP-2002-090; No Copyright; Avail: CASI; A01, Hardcopy

Powderized aluminum has long been used as an energetic ingredient in rocket propellant formulations, comprising approximately 15-20\% of some conventional ammonium perchlorate solid propellant formulations. However, the performance of aluminum is reduced by the rapid formation of an aluminum oxide overcoat on aluminum particles prior to combustion, which also inhibits efficient burning. Furthermore, formation of the oxide overcoat severely reduces the potential advantages of using high surface-to-volume-ratio ultrafine aluminum particles, which would otherwise have highly desirable properties such as enhanced burn rates. In order to inhibit the rapid formation of an oxide overcoat on the ultrafine aluminum particles without simultaneously degrading performance, it has been proposed to coat the aluminum particles with an energetic material such as HMX.
DTIC
Hmx; Rocket Propellants; Powdered Aluminum; Metal Particles

20030061400 Air Force Research Lab., Edwards AFB, CA, USA
Synthesis and Screening of Advanced Hydrocarbon Fuels
Suri, Suresh C.; Tinnirello, Michael; Marcischak, Jacob; Oct. 24, 2000; 28 pp.; In English
Report No.(s): AD-A411196; AFRL-PR-ED-TP-2000-205; No Copyright; Avail: CASI; A03, Hardcopy

These viewgraphs discuss these various goals: the HEDM program, NASA program, IHPRPT program (propellant perspective), criteria for fuel selection, approach, results and accomplishments during fiscal year 2000. The HEDM goal is to develop fuels with increased lsp over LOX/RP-1 (determined at sea level and 1000 psi chamber pressure). The IHPRPT goal (propellant contribution) is to meet IHPRPT Phase II and Phase III objectives. The NASA goal is to deliver three advanced hydrocarbon fuel in 8-10 lb. quantity and screen four hydrocarbons for their physical and hazardous properties. The criteria for fuel selection is that it predicts better performance (lsp) over LOX/RP-1 system. The most desirable physical properties are listed. The approach is thus: structural requirements, survey of energetic hydrocarbons, selection of hydrocarbons based on improved theoretical performance, synthesis of target hydrocarbons at bench scale, translate bench-scale synthesis to pilot scale.
DTIC
Hydrocarbon Fuels; Synthesis (Chemistry); NASA Programs

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COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

20030060439 International Union of Theoretical and Applied Mechanics., Stuttgart, Germany
IUTAM Symposium on Multiscale Modeling and Characterization of Elastic-Inelastic Behavior of Engineering Materials Held in Marrakech, Morocco on October 20-25, 2002
Oct. 2002; 85 pp.; In English
Contract(s)/Grant(s): N62558-02-M-6460
Report No.(s): AD-A412614; R/D-9051-EE-01S; No Copyright; Avail: CASI; A05, Hardcopy

The topics presented were wide ranging and included many aspects of deformation and fracture in a variety of materials. Among the areas that were: Developments on the constitutive connections for inelastic deformation of crystalline media, using atomistic approaches to processes such as cross slip of dislocations, but more often using dislocation models of plastic flow through formalisms of dislocation dynamics but also using models of collective dislocation activity to model incipient patterning and strain hardening. Development of deformation textures in polycrystals. Problems involving strain gradient plasticity on the sub-micron scale. Problems involving twinning in crystal plasticity and in the context of shape memory behavior. Plasticity of amorphous and semi crystalline polymers. Plasticity and fracture-related damage development in heterogeneous materials, granular materials, and composites, including the role of grain boundaries. Problems involving fracture and its mechanisms ranging from brittle cleavage to ductile cavitational forms and brittle to ductile fracture transitions, as well as in cyclic deformations. A large number of other topics related to the general theme were also presented in both the main sessions and in the poster presentations.
DTIC
Composite Materials; Elastic Properties; Inelastic Scattering

20030060452 Genoa Univ., Genoa, Italy
Mechanics of Through-Thickness Reinforced Laminates: Delamination and Dynamic Response
Massabo, Roberta; Solari, Giovanni; Dec. 2002; 88 pp.; In English
Contract(s)/Grant(s): N68171-01-M-5909
Report No.(s): AD-A412603; R/D-9084-AN-01; No Copyright; Avail: CASI; A05, Hardcopy

Through-thickness reinforcement (stitching, z-pins, weaving) is a promising technology to develop fall-safe load bearing components for aeronautical structures and lightweight armor and combat vehicles with superior capabilities. The through-thickness reinforcement enhances the performance of laminates against delamination failure, improving impact and damage tolerance and rendering stable or even suppressing crack propagadon. The purpose of the work was to investigate basic aspects of the mechanics of through-thickness reinforced laminates. Focus has been on two problems. (1) The definition and validation of approximate mode I weight functions for orthotropic double cantilever beams. The weight functions allow the problem of large scale bridging delamination to be formulated as integral equations overcoming the limitations of beam theory approximations. (2) The formulation of a theoretical model to investigate the effectiveness of a through-thickness reinforcement in reducing the delamination-induced degradation of the dynamic properties of delaminated structures. The work performed under this contract has been published in (1-4).
DTIC
Laminates; Structural Analysis

20030060564 State Univ. of New York, Stony Brook, NY, USA
The Effect of Nanoparticles Fillers on Dewetting Dynamics
Sharma, Sarika; Rafailovich, M. H.; White, H.; Sokolov, J.; Ulman, A.; Gersappe, D.; 2002 Microgravity Materials Science Conference; February 2003, pp. 475; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Nanoscale metallic particles have been added to polymers for years to significantly enhance various properties such as UV absorption, electrical conductivity, and optical dispersion. In contrast to bulk fillers, which are added in large quantities in order to reinforce structural properties, the concentration of metallic nanoparticles required to affect the electronic response is often less than 5\%. Furthermore, since these nanoparticles are coated with surfactants used as dispersants, it has been assumed that they do not interact with the polymer chains, and hence do not affect properties such as viscosity, glass transition, or interfacial tensions. Thus, not much attention has been given to the effect of fillers on thin film stability. Producing a stable polymer film is a challenge, since dewetting tends to rupture the film. Here, we report on a unique strategy to control the rate of dewetting of thin polymer films by dispersion of various nanoparticle fillers. Specular x-ray reflectivity and TEM are used to profile the distribution of the particles in and out of the plane of the substrate, respectively. Optical microscopy and Lateral force microscopy are used to study the growth rate of holes and position of the particles during the dewetting. We have carried out systematic dewetting studies of polystyrene (PS) on poly(methyl methacrylate) (PMMA) by adding functionalized fillers like Au and Pd. We show that even in the case where particles are well dispersed, large effects on the stability of the film due to dewetting may be induced by the addition of fillers. The rate of dewetting also depends upon nanoparticle concentration in the film. These results are compared with Molecular Dynamics simulations currently being conducted. As for now, these effects are not theoretically proven, but it is clear that by addition of nanoparticles a combination of equilibrium and kinetic effects can be controlled. Two separate models have been developed to prove the mechanism behind the suppression and

expression of the dewetting. The effects presented here promise to be an important means of controlling thin film stability. Author
Nanoparticles; Interface Stability; Thin Films; Drying; Fillers; Microstructure; Polymers

20030060683 Air Force Research Lab., Edwards AFB, CA, USA
Investigating the Effects of Specimen Thickness and Pressure on the Crack Growth Behavior of a Particulate Composite Material
Liu, C. T.; May 22, 2002; 14 pp.; In English; ASME Winter Meeting, 23-28 June 2002, Blacksburg, VA, USA
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410742; AFRL-PR-ED-VG-2002-128; No Copyright; Avail: CASI; A03, Hardcopy
No abstract available
Composite Materials; Crack Propagation; Stress-Strain Relationships; Specimen Geometry

20030061090 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Investigating the Effects of Confining Pressure on Cumulative Damage and the Constitutive Behavior of a Particulate Composite Material
Liu, C. T.; Yen, M.; Feb. 11, 2003; 8 pp.; In English
Report No.(s): AD-A410826; AFRL-PR-ED-TP-2003-030; No Copyright; Avail: CASI; A02, Hardcopy
In this study, the effect of strain rate on the constitutive behavior and damage state of a particulate composite material under a high confining pressure was investigated. Experimental findings reveal that, for a given strain, the stress and the damage intensity are highly dependent on the strain rate. However, the critical damage intensity is insensitive to the strain rate. DTIC
Stress-Strain Relationships; Polymers; Composite Materials; Homogeneity

20030061094 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Multi-Scale Strain Measurements of a Polymeric Material
Liu, C. T.; Chiang, Fu-Pen; February 11, 2003; 7 pp.; In English
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410828; AFRL-PR-ED-TP-2003-032; No Copyright; Avail: CASI; A02, Hardcopy
It is well known that, on the microscopic scale, polymeric materials may be' considered inhomogeneous materials. When these materials are stretched, the different crosslinking densities of polymeric chains can produce highly nonhomogeneous local stress and strength fields. Depending on the magnitude of the local stress and the local strength, damage can be developed in the material. The damage developed in the material may be in the form of microvoids or microcracks in the mater. The developed damage will not be confined to a specific location; rather, it will diffuse into a relatively large area or zone. The growth of damage in the material may take place by tearing the material or by successive nucleation and coalescence of the microvoids. These damage processes are time dependent and are the main factor responsible for the time sensitivity of strength degradation as well as the fracture behavior of the material. Therefore, in order to gain an advanced understanding of the failure process in these materials, a detailed knowledge of deformation process as well as damage initiation and evolution mechanisms are required. In this study, the strain fields, on the meso and macro scales, in a polymeric material, Solithane 113, were determined using Speckle Interferometry with Electron Midroscope (SIEM). The size of the region in which the strain fields were determined varied from 2.5 mm x 2 mm to 0.065 mm x 0.055 mm. Experimental data were analyzed and the results are discussed.
DTIC
Composite Materials; Polymers; Cracking (Fracturing); Fractures (Materials); Strain Measurement; Crack Tips

20030061100 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Experimental and Computational Failure Analysis of Graphite/Bismaleimide Laminated Composite and Carbon Foam in Sandwich Construction
Welker, Troy C.; Mar. 2003; 91 pp.; In English
Report No.(s): AD-A412789; AFIT/GAE/ENY/03-10; No Copyright; Avail: CASI; A05, Hardcopy
Sandwich beams consisting of a carbon foam core and graphite/bismaleimide face sheets were constructed and tested. Nine specimens were fabricated using three distinct cross-ply symmetric face sheet layups with a constant core thickness. Four-point bend testing controlled by a constant rate of midspan vertical displacement was used to load the specimens to

failure. Displacements and strains from the experiment were compared to analytical sandwich beam theory and displacements and failure loads were compared to a layerwise finite element solution. A phenomenological failure criterion was developed that compares favorably with experimental failure data. The finite element solution gives failure within an average of 7.58\% of experiment and a stiffness within an average of 11.16\%. The analytical sandwich beam theory predicts stiffness within 4.83\% of experiment and strain within 5.27\% of experiment. This research shows that the finite element theory has the ability to predict failure onset and location in a sandwich structure and that the face sheet layups within higher stiffness delay the onset of shear failure in the core.
DTIC
Composite Materials; Laminates; Carbon; Sandwich Structures; Finite Element Method; Fiber Composites; Mechanical Properties; Structural Failure

20030061121 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Investigating the Crack Growth Behavior in a Particulate Composite Material Under Multi-Axial Loading Conditions
Liu, C. T.; Tam, M.; Nov. 2002; 4 pp.; In English
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410936; AFRL-PR-ED-AB-2002-260; No Copyright; Avail: CASI; A01, Hardcopy

In past years, a considerable amount of work has been done studying crack growth behavior in particulate composite materials under different loading conditions at ambient pressure. The basic approach used in characterizing the crack growth behavior in the particulate composite materials is based on linear elastic or linear viscoelastic fracture mechanics. Experimental findings indicate that power law relationships exist between the crack growth rate, da/dt, and the Mode I stress intensity factor, K1. These experimental findings support the theory developed by Knauss 5 and Schapery 6 in their studies of crack growth behavior in linear viscoelastic materials. It is known that classical fracture mechanics principles, especially linear elastic fracture mechanics, are well established for single-phase materials. Experimental data indicate that linear fracture mechanics theories are applied to the particulate composite materials with varying degree of success. However, there has been relatively little effort in understanding the crack growth behavior in such materials under confining pressure condition. In this study, pre-cracked specimens were used to study the crack growth behavior in a particulate composite material, containing hard particles embedded in a rubbery matrix, under constant strain conditions at 8697 KPa confining pressure. Three different applied strain levels, 12\%, 15\%, and 18\%, were considered. In addition, the strain distributions near the crack tip were determined using imaging correlation techniques. The effects of strain levels on the crack growth behavior in the material were investigated and the results were discussed.
DTIC
Composite Materials; Crack Propagation; Particulates; Viscoelasticity; Axial Loads

20030061139 Air Force Research Lab., Edwards AFB, CA, USA
T* (sub Epsilon) Integral of a Particulate Composite
Jackson, J. H.; Lu, H.; Kobayashi, A. S.; May 22, 2002; 12 pp.; In English
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410778; AFRL-PR-ED-TP-2002-127; No Copyright; Avail: CASI; A03, Hardcopy

Digital image correlation data and the Osgood-Ramberg constitutive relation were used to evaluate the T*(sub epsilon) integral of a particulate composite SEN specimen subjected to stable crack growth. The domain size independency of the T*(sub epsilon) integral of this rubbery composite subjected to large deformation was also assessed with varying inner contours ranging from 2.0 to 5. 0 mm with domain sizes of 0.25, 0.50, and 0.75 mm. The near field J-integral decreased while the far-field J-integral continually increased with stable crack growth. The T*(sub epsilon) integral, on the other hand, approached a steady value with crack extension.
DTIC
Particulate Reinforced Composites; Integrals

20030061168 Dayton Univ. Research Inst., OH
Aerospace Composite Materials Delivery Order 0003: Nanocomposite Polymeric Resin Enhancements for Improved Composite Performance
Chen, Chenggang; Mar. 2002; 38 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F33615-00-D-5006; Proj-4347
Report No.(s): AD-A412847; UDR-TR-2002-00014; AFRL-ML-WP-TR-2002-4062; No Copyright; Avail: CASI; A03, Hardcopy

Epoxy nanocomposites were successfully prepared using different montmorillonite-based organoclays with an epoxy resin system including several added to fiber preforms. The cation exchange capacity of the clays was the most important factor affecting the clay exfoliation. The addition of clays does not significantly alter the viscosity or cure kinetics so that the modified resin will still be suitable for liquid composite molding techniques such as resin transfer molding. The cure and morphology were examined using differential scanning calorimetry and in situ small-angle x-ray scattering (SAXS). The morphology was also examined by wide- angle x-ray diffraction, SAXS, and transmission electron microscopy. The exfoliation process requires excess energy available only when the resin exothermic reaction takes place or the temperature is very high. The moduli of the polymer-silicate nanocomposites increased over the unmodified resin. The oxygen plasma erosion rates, solvent absorption in methanol and acetone, and the solvent diffusion coefficients of the nanocomposites were all reduced for the nanocomposites. The thermal oxidative properties of the nanocomposites, however, were not enhanced. Additional work is underway examining covalently bonded organic modifiers to the inorganic clays.
DTIC
Aircraft Engines; Composite Materials; Aerospace Systems; Nanotechnology

20030061170 Air Force Research Lab., Edwards AFB, CA, USA
Investigating the Crack Growth Behavior in a Particulate Composite Material Under Multi-Axial Loading Conditions
Liu, C. T.; Tam, M.; Feb. 11, 2003; 8 pp.; In English
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410751; AFRL-PR-ED-TP-2003-029; No Copyright; Avail: CASI; A02, Hardcopy
In this study, the effects of the applied strain levels on the crack growth behavior in a particulate composite material under a high confining pressure were investigated. The material under investigation contains hard particles embedded in a rubbery matrix. Three strain levels, 12\%, 15\%, and 18\%, and one confining pressures, 8697 KPa, were considered. The experimental data were analyzed and the results were discussed.
DTIC
Composite Materials; Crack Propagation; Particulates; Axial Loads

20030061250 Air Force Research Lab., Edwards AFB, CA, USA
An Investigation of Interfacial Fracture Using Experiments, Modeling, and Simulation
Miller, T. C.; Guan, E.; Todaro, Joseph; Feb. 28, 2002; 7 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410883; AFRL-PR-ED-TP-2002-044; No Copyright; Avail: CASI; A02, Hardcopy
The behavior of a bimaterial specimen consisting of a rubbery particulate composite with a thin rubber layer is studied experimentally and computationally. The purpose of the investigation is to study the behavior so fracture in the rubber material can be understood better. The paper uses computer-aided speckle interferometry to interrogate specimens deformed using tensile testing. Computational modeling of the specimens is also addressed. Key findings are different behavior for the two materials, the presence of an intermediate region, and delamination sites that are dependent on specimen geometry.
DTIC
Fracture Mechanics; Composite Materials; Rubber

20030061298 Air Force Research Lab., Edwards AFB, CA, USA
New Materials Design
Boatz, Jerry; Gordon, Mark S.; Voth, Gregory; Hammes-Schiffer, Sharon; Pachter, Ruth; May 21, 2001; 40 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410749; AFRL-PR-ED-TP-2001-122; No Copyright; Avail: CASI; A03, Hardcopy
In this paper we report our recent results on the design of materials with controlled properties by the application of computational chemistry methods, new algorithms and scalable software.
DTIC
Composite Materials; Computer Aided Design; Computational Chemistry; Computer Programs

20030061364 NASA Marshall Space Flight Center, Huntsville, AL, USA
Investigation of Carbon-Polymer Structures with Embedded Fiber-Optic Bragg Gratings
Grant, Joseph; Kaul, R.; Taylor, S.; Myers, G.; Sharma, A.; [2003]; 1 pp.; In English; NASA MSFC 2003 Propulsion Measurement Sensor Development Workshop, 13-15 May 2003, Huntsville, AL, USA; Copyright; Avail: Other Sources; Abstract Only

Several Bragg-grating sensors fabricated within the same optical fiber are buried within multiple-ply carbon-epoxy planar and cylindrical structures. Effect of different orientation of fiber-sensors with respect to carbon fibers in the composite structure is investigated. This is done for both fabric and uni-tape material samples. Response of planar structures to axial and transverse strain up to 1 millistrain is investigated with distributed Bragg-grating sensors. Material properties like Young's Modulus and Poisson ratio is measured. A comparison is made between response measured by sensors in different ply-layers and those bonded on the surface. The results from buried fiber- sensors do not completely agree with surface bonded conventional strain gauges. A plausible explanation is given for observed differences. The planar structures are subjected to impacts with energies up to 10 ft-lb. Effect of this impact on the material stiffness is also investigated with buried fiber-optic Bragg sensors. The strain response of such optical sensors is also measured for cylindrical carbon-epoxy composite structures. The sensors are buried within the walls of the cylinder as well as surface bonded in both the axial as well as hoop directions. The response of these fiber-optic sensors is investigated by pressurizing the cylinder up to its burst pressure of around 1500 psi. This is done at both room temperature as well as cryogenic temperatures. The recorded response is compared with that from a conventional strain gauge.
Author
Composite Structures; Bragg Gratings; Optical Fibers; Strain Measurement; Fiber Orientation

20030061421 Defence Research and Development Canada, Ottawa, Ontario, Canada
Study of a Waveguide Antenna Implemented in Laminated Material
Litzenberger, Jack O.; Clenet, Michel; Morin, Gilbert A.; Antar, Yahia M.; Dec. 2002; 152 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411408; DRDC-TR-2002-132; No Copyright; Avail: CASI; A08, Hardcopy

This document presents the investigation of a novel end-fire antenna implemented in laminated material. This study is related to the development of a phased array for the AEHF Military Satellite Communication Systems. This work includes theoretical analysis, computation of the developed models and measurement of the realised prototypes at 20.7GHz. The antenna element consists of a radiating rectangular waveguide. As a laminated dielectric material, like LTCC material, is supporting the antenna, the vertical walls need to be formed with vias of specific pitch. An effective coaxial-to-waveguide transition has also been developed to feed the radiating element. The results show that this laminated waveguide can be used as an integrated radiating element in the AEHF band for military satellite communications. A five-element array has also been prototyped. Although the results show low mutual coupling between the elements, additional work needs to be carried out to improve the array radiation characteristics.
DTIC
Laminates; Waveguide Antennas; Ceramics; Satellite Communication; Military Spacecraft

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INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY

Includes the analysis, synthesis, and use of inorganic and organic compounds; combustion theory; electrochemistry; and photochemistry. For related information see category *34 Fluid Dynamics and Thermodynamics*. For astrochemistry see category *90 Astrophysics*.

20030059522 CH2M Hill Hanford Group, Inc., Richland, WA
Chemistry of Flammable Gas Generation, Revision 1
Stock, L. M.; Sep. 27, 2001; 186 pp.; In English
Report No.(s): DE2003-807324; No Copyright; Avail: Department of Energy Information Bridge

The document collects information from field instrumentation, laboratory tests, and analytical models to provide a single source of information on the chemistry of flammable gas generation at the Hanford Site. It considers the 3 mechanisms of formation: radiolysis, chemical reactions, and thermal generation. An assessment of the current models for gas generation is then performed. The resu1ts are that the various phenomena are reasonably understood and modeled compared to field data.
NTIS
Chemical Reactions; Flammable Gases; Mathematical Models; Field Tests

20030059527 Materials Research Society, Warrendale, PA

Materials Research Society Symposium Proceedings. Volume 723. Molecularly Imprinted Materials - Sensors and Other Devices. Symposia Held in San Francisco, California on April 2-5, 2002

Shea, Kenneth J.; Yan, Mingdi; Roberts, M. J.; Cremer, Paul S.; Crooks, Richard M.; Apr. 5, 2002; 172 pp.; In English

Contract(s)/Grant(s): N00014-02-1-0149

Report No.(s): AD-A412559; No Copyright; Avail: CASI; A08, Hardcopy

This symposium proceeding contains papers presented at Symposium M, 'Molecularly Imprinted Materials,' and Symposium O, 'Chemical and Biological Sensors - Materials and Devices,' held April 2-5 at the 2002 MRS Spring Meeting in San Francisco, California. Symposium M was the first of its kind at a Materials Research Society Meeting. The symposium consisted of 17 talks and 15 posters and brought together a number of scientists in the field to discuss the current state of the art in molecular imprinting. Topics included microfabrication, imprinted membranes, and nanoparticles, covalent and non-covalent methods of molecular imprinting, separate technology, and sensor applications. Symposium O contained 45 presentations that covered topics that included microfluidics and sensing systems, sensor arrays and devices, sensing with nanoparticles, monolayers, bilayers, cells, and silicon.

DTIC

Polymerization; Composite Materials

20030059534 Wisconsin Univ-Madison Board of Regents/Research Sponsored Programs, Madison, WI, USA

SONICFLIP: An Integrated Platform for Biofluid Monitoring

Lal, Amit; Jan. 2003; 45 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): F30602-00-2-0572; Proj-E117

Report No.(s): AD-A412580; AFRL-IF-RS-TR-2002-320; No Copyright; Avail: CASI; A03, Hardcopy

The work concerns the focused goal of developing technologies to miniaturize microfluidics for wrist-watch scale assays of biofluids such as interstitial fluids and blood. The platform consists of a microfluidic system driven by an array of piezoelectric pillars. This array is then driven by CMOS electronics. This architecture enables the division of manufacturing between IC manufacturers, piezoelectric chip producers, and microfluidic chip producers in a stacked manner that can fit in a wristwatch format. We demonstrate use of projected ultrasonic fields for distributed forces inside microchannels for programmable microfluidics inside plastic and silicon microfluidic structures. The work also demonstrates resonating structures inside microfluidic channels that can manipulate ultrasonic forces around the structures in a controlled manner for particle trapping. We also demonstrate a strategy for sub-5V and sub 5-milliWatt valve using piezoelectric unimorphs connected to the microfluidic chip via magnetically extruded pillars.

DTIC

Blood; Chips (Electronics); Measuring Instruments

20030060447 General Atomics Co., San Diego, CA, USA

General Atomics Supercritical Water Oxidation Processing of Redwater from TNT Production

Elliott, James; Ordway, David; Rising, Stanley; Kwak, Solim; Hurley, James; Feb. 2003; 17 pp.; In English

Contract(s)/Grant(s): F08630-02-C-0083

Report No.(s): AD-A412465; AFRL-ML-TY-TP-03-4529; No Copyright; Avail: CASI; A03, Hardcopy

GA performed fourteen experimental runs between the October, 2002 and February, 2003 utilizing the SCW Test Unit during this Redwater testing program. Initial experiments processed Redwater waste simulants tailored to match the salt species and concentrations anticipated with actual Redwater. Later experiments utilized actual Redwater waste material obtained from an operational TNT production plant. The initial experiments generated the critical data needed to configure the SCW test system and optimize the processing conditions for the successful treatment of Redwater. Initial Redwater runs were of short duration to allow further fine tuning of the process parameters. Additionally, these shorter runs provided liquid and gaseous samples for analytical analysis to confirm effective Redwater processing. The program culminated in a twenty one hour test to confirm the application of the SCWO process for extended duration Redwater processing.

DTIC

Supercritical Fluids; Oxidation; Water Treatment; Atomic Interactions; Trinitrotoluene

20030060484 Cornell Univ., Ithaca, NY

PDF Modelling of Turbulent Combustion

Pope, Stephen B.; Sep. 2002; 59 pp.; In English

Contract(s)/Grant(s): F49620-00-1-0171

Report No.(s): AD-A411692; AFRL-SR-AR-TR-03-0068; No Copyright; Avail: CASI; A04, Hardcopy

Significant advances have been made in several aspects of the computational modelling of turbulent combustion. PDF model calculations have been performed of turbulent piloted-jet non-premixed flames. The results demonstrated the ability of the methodology to account, accurately, for the local extinction and reignition observed experimentally in these flames. It was shown that these flames can be sensitive to the temperature of the pilot and to radiative heat loss. A new approach has been developed for the efficient computational implementation of combustion chemistry. The rate controlled constrained equilibrium method has been combined with the in Situ adaptive tabulation algorithm to produce a unified dimension-reduction/storage-retrieval methodology for the computationally-efficient implementation of combustion chemistry. Test calculations demonstrated that this methodology has comparable accuracy to augmented reduced mechanisms. Ideas from the conditional moment closure and the mapping closure have been combined to produce a new approach for modeling molecular mixing in turbulent reactive flows. The new methodology has been shown to describe accurately (for the first time) the mixing of two scalars. A methodology has been developed for obtaining stochastic models for Lagrangian velocity and acceleration based on DNS data from homogeneous turbulent shear flow. It has been shown that the acceleration model provides a remarkably accurate representation of the observed Lagrangian velocity-acceleration two-time correlations. In collaboration with the group of Prof. P. Givi, advances have been made in the implementation of a combined LES/PDF methodology for modeling turbulent reactive flows. The approach based on the velocity filtered density function has been applied to a spatially developing mixing layer and shown to account well for the major processes in this flow.
DTIC
Turbulent Flow; Probability Density Functions; Combustion

20030060485 City Univ. of New York, NY
Application of the Optimized Effective Potential Method to Quantum Chemistry
Krieger, Joseph B.; Apr. 19, 2002; 23 pp.; In English
Contract(s)/Grant(s): DAAG55-98-1-0027
Report No.(s): AD-A411992; ARO-37339.1-CH; No Copyright; Avail: CASI; A03, Hardcopy

The difficulties in conventional density functional theory (DFT) are discussed. An alternative exact procedure, the Optimized Effective Potential (OEP) method, is discussed and its analytic properties that are significant in DFT are presented. The difficulties in solving the integral equation for the OEP are eliminated by the introduction of the Krieger-Li-Iafrate (KLI) approximation which leads to important analytic properties that are identical to those of the OEP. Detailed self-consistent calculations on atoms and negative ions demonstrate that the KLI yields results that are nearly identical to those of the OEP and are a significant improvement over those given by the local spin density approximation and its gradient corrected versions. Calculations have been extended to molecules in the exchange-only approximation and are close to Hartree-Fock results. An accurate self-interaction-free correlation energy functional has been constructed from considerations of a homogeneous electron gas with an energy gap. Calculations on atoms, molecules and surfaces demonstrate that this functional is at least as accurate as any alternative generalized gradient approximation. The contributions from low lying virtual states is being studied.
DTIC
Quantum Chemistry; Hartree Approximation; Optimization; Methodology

20030060530 Vanderbilt Univ., TN, USA
Recovery of Minerals in Martian Soils Via Supercritical Fluid Extraction
Kebelak, K. A.; Roth, J. A.; Wang, T.; 2002 Microgravity Materials Science Conference; February 2003, pp. 155-166; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

This investigation involves the determination of the solubilities of inorganic compounds in supercritical carbon dioxide, which is basic property information of these inorganic compounds. If there are inorganic compounds which have associated with them water of hydration which are soluble in supercritical carbon dioxide, then a process which extracts these compounds in supercritical carbon dioxide could be developed to recover water on Mars. In addition, supercritical carbon dioxide may react with certain inorganic compounds producing water as a by-product of the reaction
Author
Extraction; Inorganic Compounds; Mars Surface; Minerals; Supercritical Fluids; Soils

20030060577 Florida Univ., Gainesville, FL, USA
The Features of Self-assembling Organic Bilayers Important to the Formation of Anisotropic Inorganic Materials in Microgravity Conditions
Talham, Daniel R.; Adair, James H.; 2002 Microgravity Materials Science Conference; February 2003, pp. 616-621; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Materials with directional properties are opening new horizons in a variety of applications including chemistry, electronics, and optics. Structural, optical, and electrical properties can be greatly augmented by the fabrication of composite materials with anisotropic microstructures or with anisotropic particles uniformly dispersed in an isotropic matrix. Examples include structural composites, magnetic and optical recording media, photographic film, certain metal and ceramic alloys, and display technologies including flat panel displays. The new applications and the need for model particles in scientific investigations are rapidly outdistancing the ability to synthesize anisotropic particles with specific chemistries and narrowly distributed physical characteristics (e.g. size distribution, shape, and aspect ratio). While there has been considerable progress toward developing an understanding of the synthesis of powders composed of monodispersed, spherical particles, efforts to prepare anisotropic nanoparticles are lagging. Amphiphilic molecules can be used to prepare either water-in-oil or oil-in-water micelles, and these organic template structures have been used to control the size of growing inorganic particles. Larger concentrations of the segregated phase leads to the formation of bilayer structures. In our laboratories, we have demonstrated that these anisotropic micellular structures can be used as templates to prepare anisotropic particles in both metallic and inorganic salt systems. This project aims to extend the methods that have been developed to other inorganic particle systems and to increase our level of understanding of how anisotropic particles are formed at lamellar templates.
Derived from text
Anisotropy; Microgravity; Self Assembly; Microstructure; Nanoparticles; Semiconductors (Materials); Inorganic Materials

20030060591 University of Southern California, Los Angeles, CA, USA
Self-Propagating Frontal Polymerization in Water at Ambient Pressure
Olten, Nesrin; Kraigsley, Alison; Ronney, Paul D.; 2002 Microgravity Materials Science Conference; February 2003, pp. 505-509; In English; See also 20030060494; Original contains color illustrations
Contract(s)/Grant(s): NAG8-1701; No Copyright; Avail: CASI; A01, Hardcopy

Advances in polymer chemistry have led to the development of monomers and initiation agents that enable propagating free-radical polymerization fronts to exist. These fronts are driven by the exothermicity of the polymerization reaction and the transport of heat from the polymerized product to the reactant monomer/solvent/initiator solution. The thermal energy transported to the reactant solution causes the initiator to decompose, yielding free radicals, which start the free radical polymerization process as discussed in recent reviews. The use of polymerization processes based on propagating fronts has numerous applications. Perhaps the most important of these is that it enables rapid curing of polymers without external heating since the polymerization process itself provides the high temperatures necessary to initiate and sustain polymerization. This process also enables more uniform curing of arbitrarily thick samples since it does not rely on heat transfer from an external source, which will necessarily cause the temperature history of the sample to vary with distance from the surface according to a diffusion-like process. Frontal polymerization also enables filling and sealing of structures having cavities of arbitrary shape without having to externally heat the structure. Water at atmospheric pressure is most convenient solvent to employ and the most important for practical applications (because of the cost and environmental issues associated with DMSO and other solvents). Nevertheless, to our knowledge, steady, self-propagating polymerization fronts have not been reported in water at atmospheric pressure. Currently, polymerization fronts require a high boiling point solvent (either water at high pressures or an alternative solvent such as dimethyl sulfoxide (DMSO) (boiling point 189 C at atmospheric pressure.) Early work on frontal polymerization, employed pressures up to 5000 atm in order to avoid boiling of the monomer/solvent/initiator solution. High boiling point solutions are needed because in order to produce a propagating front, a high front temperature is needed to produce sufficiently rapid decomposition of the free radical initiator and subsequent free radical polymerization and heat release at a rate faster than heat losses remove thermal energy from the system. (While the conduction heat loss rate increases linearly with temperature, the free radical initiator decomposition is a high activation energy process whose rate increases much more rapidly than linearly with temperature, thus as the temperature decreases, the ratio of heat loss to heat generation increases, eventually leading to extinction of the front if the temperature is too low.) In order to obtain atmospheric pressure frontal polymerization in water, it is necessary to identify a monomer/initiator combination that is water soluble and will not extinguish even when the peak temperature (T*) is less than 100 C. In this work acrylic acid (AA) was chosen as the monomer because is it one of the most reactive monomers and can polymerize readily at low temperatures even without initiators. Ammonium persulfate (AP) was chosen as the initiator because it decomposes readily at low temperatures, produces relatively few bubbles and is commercially available. The propagation rates and extinction conditions of the fronts are studied for a range of AA and AP concentrations. Small amounts of fumed silica powder (Cab-o-sil, Cabot Corporation) were added to the solutions to inhibit buoyancy induced convection in the solutions; future studies will investigate the effects of buoyant convection within the solutions.
Author
Polymerization; Atmospheric Pressure; Water; Acrylic Acid

20030060638 Georgia Inst. of Tech., Atlanta, GA, USA

Suppression of Combustion Instability by Controlling Spray Properties in Liquid-Fueled Combustors

Lee, J.-Y.; Lubarsky, E.; Zinn, B. T.; Feb. 28, 2003; 17 pp.; In English

Contract(s)/Grant(s): F49620-02-1-0035

Report No.(s): AD-A412486; AFRL-SR-AR-TR-03-0075; No Copyright; Avail: CASI; A03, Hardcopy

This paper describes an experimental investigation of 'slow' active control of combustion instabilities by changing the liquid fuel spray properties. Such control approach whose characteristic time is generally much longer than that of the period of the unstable oscillations needs 'one time' variation of control inputs in response to changes in engine operating conditions. Using two types of fuel injectors that can produce large controllable variation of fuel spray properties, this study examined the dependence of acoustics-combustion process coupling, i.e., the driving of combustion instabilities upon liquid fuel spray droplet size, which affects the characteristic combustion time and, thus, the coupling between the acoustics and the combustion process. It was demonstrated that changing the spray characteristics significantly damps the instabilities. The results of this study strongly suggest that 'slow' active control of the fuel spray droplet sizes with advanced injectors in real engines could be used to prevent the onset of detrimental combustion instabilities.

DTIC

Combustion; Fuel Sprays; Retarding; Stability; Combustion Chambers

20030060640 Air Force Research Lab., Edwards AFB, CA, USA

Direct Simulation Monte Carlo Modeling of High Energy Chemistry in Molecular Beams: Chemistry Models and Flowfield Effects

Braunstein, M.; Wysong, I. J.; Jun. 28, 2000; 13 pp.; In English

Report No.(s): AD-A412489; AFRL-PR-ED-TP-2000-143; No Copyright; Avail: CASI; A03, Hardcopy

Underlying the many models for simulating chemistry in rarefied gas flows are the cross sections for fundamental chemical processes occurring at high energy and under non-equilibrium conditions. As a rule, these cross sections are not known and must be extrapolated from thermal equilibrium measurements often beyond their measured energy range and far from thermal equilibrium. Large errors in the derived reaction probability can occur which are reflected in uncertainties in chemically reacting flow results. The problem of extracting cross sections from measured thermal data becomes even more difficult when a detailed quantum state specific cross section description is needed. In this paper, benchmark state-to-state cross sections previously obtained on O+CO -vibrational energy excitation and chemical exchange reaction provide an opportunity to check the validity of widely used models for computing reaction probabilities from measured equilibrium reaction rates. The benchmark cross sections are converted to reactions probabilities based on the variable hard sphere (VHS) model for the total collision cross section and compared to extrapolations based on thermal measurements. To illustrate the impact of the use of the proper state-specific cross section on the results of rarefied gas simulations, the benchmark cross sections are used in the DSMC modeling of a high energy pulsed (non-steady) crossed-molecular beam experiment (MBE). Results from these simulations show how uncertainties in the input reaction cross sections are reflected in the predicted excited state populations and infrared radiation signature of the product molecules. A fully three dimensional DSMC simulation including reactive chemistry, energy exchange and radiative decay processes is described and used in the modeling. In addition, it is shown how these DSMC simulations can be an important diagnostic tool, enabling a more a

DTIC

Monte Carlo Method; Molecular Beams; Rarefied Gases

20030060665 Georgia Inst. of Tech., Atlanta, GA

Intelligent Turbine Engine

Zinn, Ben T.; Allen, M.; Brooke, M.; Glezer, A.; Haddad, W.; Jan. 31, 2002; 68 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): DAAH04-96-1-0008

Report No.(s): AD-A412511; ARO-3499.50-EG-MUR; No Copyright; Avail: CASI; A04, Hardcopy

This study investigated technologies needed for the development of advanced turbine engines (TE) control systems that could improve TE performance and safety and reduce ownership cost. Since such control systems generally consist of one or more sensors, a control system and one or more actuators, this program investigated novel approaches for improved sensing, control and actuation in TE combustors and compressors. A multidisciplinary team of faculty from the school of Aerospace, Electrical and Computer and Mechanical engineering performed this study. Notable accomplishments of this program include: high temperature, wireless MEMS sensors, optical approaches for real time monitoring of combustor efficiency and pattern factor, 3, a 'smart' fuel injector for controlling combustor performance, a synthetic jet actuator for improved combustor mixing

processes and pattern factor, nonlinear robust and adaptive controllers for combustion and compression systems, a Neural Network Chip for controlling combustion instabilities, LES and CFD for modeling unsteady combustor and compressor flows, respectively, and active control approaches for unstable compressors.
DTIC
Gas Turbines; Actuators; Turboshafts; Turbofan Engines

20030060668 Air Force Research Lab., Edwards AFB, CA, USA
TTCP Ingredients for Energetic Materials: Air Force Research Laboratory, Edwards AFB, CA
Drake, Greg; Mar. 16, 2001; 3 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A412512; AFRL-PR-ED-TP-2001-057; No Copyright; Avail: CASI; A01, Hardcopy

Fundamental Chemistry in oxidizers: Work on novel polynitrogen continues at the Edwards Air Force Base in Karl Christe's group. The N5(+)SbF6(-) salt was fully characterized and its crystal structure determined. The salt is thermally surprisingly stable (70 deg C) and exhibits very little impact sensitivity, Safer methods for the synthesis of N5(+)SbF6(-) have been developed and the salt is routinely prepared on a 5 g scale. Ongoing and future work is aimed at the syntheses of combinations of N5(+) with energetic counterions and novel large polynitrogen anions.
DTIC
Nitrogen Compounds; Inorganic Compounds; Physical Properties

20030060678 California Univ Regents Santa Barbara Office of Research
New Hybrid Route to Biomimetic Synthesis
Morse, Daniel E.; Mar. 21, 2003; 76 pp.; In English
Contract(s)/Grant(s): DAAH04-96-1-0443
Report No.(s): AD-A412677; ARO-36272.121-MS-MUR; No Copyright; Avail: CASI; A05, Hardcopy

To develop economical low-temperature routes to biomimetic synthesis of high-performance composite materials, with control of composition and structure based on the molecular mechanisms controlling biomineralization of calcium- and silicon-based nanocomposites. HIGHLIGHTS: We report success in our originally proposed transition from analysis of biological systems to the development of useful applications across a broad range of materials. We discovered that the silicateins - proteins we originally discovered responsible for the structure-directing catalysis of polymerization to form silica and silsesquioxanes - also can be used for the structure-directing polymerization of titanium dioxide from the appropriate water-stable alkoxide precursor. This result dramatically extends our initial development of the new field we called 'Silicon Biotechnology' to an even broader 'Functional Inorganic Materials Biotechnology. '
DTIC
Biomimetics; Silicon Dioxide

20030060686 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
A Gas-Solid Singlet Delta Oxygen Generator for the Chemical Iodine Laser
Alfano, Angelo; Christe, Karl; Corley, Robert; Apr. 30, 2002; 4 pp.; In English
Contract(s)/Grant(s): F04611-99-C-0025; Proj-1011
Report No.(s): AD-A410767; AFRL/PRS-ED-TP-2002-092; No Copyright; Avail: CASI; A01, Hardcopy

The chemical oxygen-iodine laser (COIL) involves the production of electronically excited singlet delta oxygen at 1.27 microns by passing chlorine gas through aqueous, basic hydrogen peroxide (H2O2/OH). Unfortunately, the process of nonradiative relaxation used in COIL results in the creation of undesired heat and not the desired light emission. Several patented developments have addressed this need to rapidly extract the excited oxygen from its quenching, aqueous environment and efficiently mix it with iodine for subsequent lasing at 1.3 microns. One response to the problems with aqueous COIL chemistry was AFRL's development of the all gas-phase iodine laser (AGIL). The AGIL produces excited nitrogen chloride from chlorine atoms and gaseous hydrogen azide. However, AGIL is compromised by the explosion hazards of its HN3 chemistry. In an effort to improve the safety and reduce the complexity of COIL and AGIL, chemists in AFRL's Propulsion Directorate at Edwards AFB investigated alternative means of preparing singlet delta oxygen from safe starting materials while avoiding liquid-phase quenching problems. Solid-solid, solid pyrolysis, and gas-solid reactions were investigated. Their breakthrough came when singlet delta oxygen was produced with solid alkali metal/alkaline earth peroxides and gaseous hydrogen/deuterium halides. The production of singlet delta oxygen was verified by observing its emission at 1.27 microns and comparing the emission wavelength and band contour with well-known singlet delta oxygen

sources. The nonhazardous, commercially available reagents react nonviolently and the products are oxygen, water, and benign alkali metal or alkaline earth-halide salts. Further development of this concept could provide an improved singlet delta oxygen generator that utilizes the already available COIL technology for iodine atom production, oxygen-iodine atom mixing, and 1.3 micron laser light extraction. (4 refs.)
DTIC
Chemical Oxygen-Iodine Lasers; Gas-Solid Interactions; Oxygen Production

20030060694 Missouri Univ., Columbia, MO, USA
Nanocomposite Diamond and Nitride Films on Structural Materials
White, Henry W.; 28 May 2001; 3 pp.; In English
Contract(s)/Grant(s): DAAH04-94-G-0305
Report No.(s): AD-A412706; No Copyright; Avail: CASI; A01, Hardcopy

Three different types of plasma deposition systems were constructed for film syntheses. 1) A laser absorption wave deposition (LAWD) was constructed to deposit diamond and diamond like films and nitride based films on steel, aluminum and other substrates from flowing methane/hydrogen mixtures. A pulsed infraredYAG laser was used to create simultaneously two plasmas-from the flowing gas mixture and from the substrate onto which the film was to be deposited. 2) An electron cyclotron resonance microwave plasma enhanced chemical vapor deposition system was designed and used to grow diamond and diamond-like films on structural materials such as Fe-based alloys (316 stainless steel). Films were grown at low temperatures (400 C and below) from methane/hydrogen mixtures, without use of diamond seeding and without use of a template layer between the Fe-based substrate and the diamond-like film. 3) A pulsed UV krypton-ion laser deposition system was constructed for growth of structured oxide films. ZnO films were grown on various substrates. A method for p-type doping of ZnO films was developed for use in creating p-n junctions for electronic device applications.
DTIC
Thin Films; Diamonds; Nitrides

20030061067 Air Force Research Lab., Edwards AFB, CA, USA
New Materials Design
Voth, Gregory; Pachter, Ruth; Gordon, Mark; Boatz, Jerry A.; Apr. 28, 1998; 9 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410752; AFRL-PR-ED-TP-1998-088; No Copyright; Avail: CASI; A02, Hardcopy

Progress has been made on several projects under the Challenge Project award. In the area of high energy density materials, calculations are under way on Al atoms embedded in clusters of 112 molecule. These calculations are very demanding, since very large basis sets and high levels of theory are required to obtain sufficient accuracy for these really bound species. Potential energy surfaces are being determined to assess the mobility of an Al atom in H2 matrices. Similar analyses are underway for B, Be, and Mg atoms. In another HEDM project, a series of large, nitrogen-containing rings, suggested as HEDM targets by Dr. Rob Schmitt at SRI, are being studied. The first of these has been shown to have a very large heat of formation and specific impulse, so it is a very promising species. Calculations on the second compound are in progress. Subsequent calculations will analyze the sensitivity of these compounds to environmental interactions (e.g., hydrolysis, acid/base attack, oxygen). Calculations of the structures and hydrogen bonding interactions present in 1, 1-diamino-2,2-dinitroethene, a new energetic material with low friction sensitivity, are also underway.
DTIC
High Energy Propellants; Rocket Propellants

20030061104 Air Force Research Lab., Edwards AFB, CA, USA
Computational Analysis of a Single-Element, Shear-Coaxial, GH2/GO2 Engine
Archambault, Mark; Cohn, Richard; Talley, Doug; Peroomian, Oshin; Apr. 12, 2001; 7 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A412802; AFRL-PR-ED-AB-2001-082; No Copyright; Avail: CASI; A02, Hardcopy

A computational and experimental program of research in gas/gas injection has been initiated in support of staged combustion cycle engines. The overall objective of this research is to develop a design methodology for gas/gas injectors. This paper, however, focuses on a computational methodology to efficiently, accurately, and robustly obtain high-fidelity solutions of combusting rocket engine flows to gain a knowledge and understanding of their features. To that end, simulations of a single-element, shear-coaxial, H2/O2 engine are being performed to characterize its flow field and to validate the CFD% flow'

solver for this class of problems. Thus far, solutions have been obtained on a grid containing 53740 cells, three to four times the number of cells used by other researchers,1,2 using four and eight processors on an SGI origins 2000 computer. The code solves the two-dimensional, compressible, real gas equations with a second-order accurate spatial discretization scheme. Currently, a standard, realizable k-epsilon turbulence model is employed to resolve the turbulent mixing, and the constant-pressure combustion model is used in combination with a 9 species, 19 reactions finite-rate kinetics model.
DTIC
Rocket Engines; Turbulent Flow

20030061106 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
A Renaissance in Noble-Gas Chemistry
Christe, Karl O.; Feb. 12, 2001; 12 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410904; AFRL-PR-ED-TP-2001-034; No Copyright; Avail: CASI; A03, Hardcopy

In spite of the predictions of stable noble-gas compounds since at least 1902, unsuccessful attempts at their synthesis gave rise to the widely held opinion that noble-gases are not only noble but also inert . Thus, dogma-like statements to this effect could be found in practically every chemistry textbook and discouraged or a long time, experimentalists to work in this area. It was not until 1962 that this dogma was shattered when Bartlett in Canada and Hoppe in Germany independently discovered with XePtF6 and XeF2, respectively, the first stable noble-gas compounds. These discoveries triggered an explosion of worldwide frenzy in this area and within a short span of time many new xenon, radon and krypton compounds were prepared and characterized. About 30 years and many publications later, new results in this area had slowed down to a trickle and in the minds of most chemists the chapter on noble-gas chemistry had been completed. A recent burst of startling discoveries, however, shows that noble-gas chemistry is still full of surprises and may signal the beginning of a renaissance in this field.
DTIC
Rare Gases; Rare Gas Compounds

20030061119 Envirogen, Inc., Lawrenceville, NJ
In situ Bioremediation of Perchlorate
May 21, 2002; 175 pp.; In English
Report No.(s): AD-A412744; SERDP-CU-1163-2; No Copyright; Avail: CASI; A08, Hardcopy

The objective of this project is to develop a biological treatment technology for in situ remediation of perchlorate in subsurface environments. The development of an effective technology for perchlorate remediation requires a fundamental understanding of the conditions that limit biological perchlorate reduction in groundwater and the most effective means to overcome such limitations. This research effort is designed to provide this fundamental understanding. We hypothesize that four key factors may be contributing to the persistence of perchlorate at various subsurface sites. These key factors and our approach to their evaluation in the research paper are as follows: (1) Absence of an appropriate substrate (electron donor) for growth of indigenous perchlorate degrading bacteria; (2) Presence of alternative electron acceptors for bacterial respiration, including 02, NO3, and NO2 in groundwater; (3) Lack of an indigenous population of bacteria capable of perchlorate reduction; and (4) Unfavorable environmental conditions for activity of indigenous perchlorate degraders.
DTIC
Water Pollution; Perchlorates; Chemical Reactions

20030061129 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Plume Phenomenology Program
Levine, Jay; Jun. 4, 1999; 11 pp.; In English
Contract(s)/Grant(s): Proj-5503
Report No.(s): AD-A410925; AFRL-PR-ED-TP-99-0106; No Copyright; Avail: CASI; A03, Hardcopy

Slides for international presentation on Air Force Research Laboratory research into plume phenomenology.
DTIC
Phenomenology; Plumes

20030061140 Pratt and Whitney West Palm Beach FL, West Palm Beach, FL, USA
Hot Firing of a Full Scale Copper Tubular Combustion Chamber
Cooley, C.; Fentress, S.; Jennings, T.; May 2002; 15 pp.; In English
Contract(s)/Grant(s): F04611-95-C-0123; Proj-4373
Report No.(s): AD-A411103; AFRL-PR-ED-TP-2002-078; No Copyright; Avail: CASI; A03, Hardcopy

This paper describes the chamber design and hot firing test results for a full-scale copper tubular combustion chamber that has future application in a high-thrust, upper-stage expander cycle engine. The Advanced Expander Combustor (AEC) was developed by Pratt & Whitney Space Propulsion under contract with AFRL to support the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) initiative. The AEC copper tubular design combines high material thermal conductivity and large effective surface area in a structurally compliant coolant channel configuration to achieve significant heat pick-up from the combustion gases to the coolant. AEC hot fire test data analysis confirmed the ability to achieve high thrust in an expander cycle engine using a copper tubular construction. Heat transfer enhancement due to the tubular chamber liner construction was shown to be in the range of 29\% to 46\% at typical operating conditions compared with a smooth wall copper liner design. Until recently, no significant improvement in chamber tube thermal conductivity was available without an unacceptable sacrifice in material properties such as strength, Low Cycle Fatigue, and oxidation/erosion capability. The development of PWA 1177 dispersion strengthened copper addressed this unacceptable trade off. This material provides high strength, high thermal conductivity, and excellent oxidation resistance. The AEC used PWA 1177 in its chamber design to provide the increased heat transfer and resultant energy necessary to support the high thrust required to meet IHPRPT's goals. The technology developed during the AEC fabrication and test program is currently being used by Pratt & Whitney in the development of the RL60, a high-performance 60,000 pound thrust expander cycle engine.
DTIC
Combustion Chambers; Fabrication; Firing (Igniting); Spacecraft Propulsion; Copper Alloys; Liquid Propellant Rocket Engines

20030061186 NASA Glenn Research Center, Cleveland, OH, USA
Carbon Nanostructure Examined by Lattice Fringe Analysis of High Resolution Transmission Electron Microscopy Images
VanderWal, Randy L.; Tomasek, Aaron J.; Street, Kenneth; Thompson, William K.; Hull, David R.; May 2003; 18 pp.; In English; Original contains black and white illustrations
Contract(s)/Grant(s): NCC3-975; NCC3-544; WBS 101-12-06
Report No.(s): NASA/TM-2003-212214; NAS 1.15:212214; E-13835; No Copyright; Avail: CASI; A03, Hardcopy
The dimensions of graphitic layer planes directly affect the reactivity of soot towards oxidation and growth. Quantification of graphitic structure could be used to develop and test correlations between the soot nanostructure and its reactivity. Based upon transmission electron microscopy images, this paper provides a demonstration of the robustness of a fringe image analysis code for determining the level of graphitic structure within nanoscale carbon, i.e., soot. Results, in the form of histograms of graphitic layer plane lengths, are compared to their determination through Raman analysis.
Author
Transmission Electron Microscopy; Nanostructure (Characteristics); Carbon; Soot; Oxidation; Reactivity

20030061251 Air Force Research Lab., Edwards AFB, CA, USA
Synthesis and Characterization of the SO2N3(-), (SO2)2N3(-), and SO3N3(-) Anions
Christe, Karl O.; Boatz, Jerry A.; Gerken, Michael; Haiges, Ralf; Schneider, Stefan; Mar. 6, 2002; 51 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410905; AFRL-PR-ED-TP-2002-048; No Copyright; Avail: CASI; A04, Hardcopy
SO2 solutions of azide anions are bright yellow and their Raman spectra indicate the presence of covalently bound azide. Removal of the solvent at -64 deg C from CsN3 or N(CH3)4N3 solutions produces yellow (SO2)2N3(-) salts. Above -64 deg C, these salts lose one mole of SO2, resulting in white SO2N3 salts that are marginally stable at room temperature and thermally decompose to the corresponding azides and SO2.
DTIC
Synthesis (Chemistry); Raman Spectra; Azides (Inorganic)

20030061253 Air Force Research Lab., Edwards AFB, CA, USA
Energetic, Low Melting Salts of Simple Heterocycles
Darke, Greg; Hawkins, Tommy; Brand, Adam; Mckay, Milton; Ismail, Ismail; Jan. 18, 2003; 20 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410888; AFRL-PR-ED-TP-2003-007; No Copyright; Avail: CASI; A03, Hardcopy
The synthesis of three new families of heterocyclic based salts was undertaken and accomplished. Three triazole systems, 1-H-1, 2, 4-triazole 4-amino-1, 2, 4-triazole, and 1-H-1, 2, 3-triazole were used as proton bases with nitric (HNO3), perchioric

(HClO4), and dinitramidic ('HN(NO2)2') acid systems. in all cases, stable salts were recovered and fully characterized by vibrational spectra (IR, Raman), multinuclear nmr spectroscopy, material balance, density measures, elemental analyses, as well as DSC, TGA and initial safety testing (impact). Many of these salts have melting points well below 1 000C, yet high decomposition onsets, defining them as new, highly energetic members of the well known class of materials identified as ionic liquids.
DTIC
Salts; Heterocyclic Compounds

20030061255 Air Force Research Lab., Edwards AFB, CA, USA
Probing Quantum Solvation with Infrared Spectroscopy: Infrared Activity Induced in Solid Parahydrogen by N2 and Ar Dopants
Hinde, Robert J.; Anderson, David T.; Tam, Simon; Fajardo, Mario E.; Sep. 6, 2001; 6 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410903; AFRL-PR-ED-TP-2001-182; No Copyright; Avail: CASI; A02, Hardcopy

We present high-resolution infrared absorption spectra of solid parahydrogen matrices containing low concentrations of N2 or Ar impurities. The spectra reveal dopant-induced absorption features that acquire infrared activity through short-range isotropic vibrational transition dipole moments arising from dopant-H2 intermolecular interactions. These dopant-induced features provide new insights into the perturbation of the vibron bands of the H2 matrix by chemical impurities, and thus into the physics of solvation in a quantum solid.
DTIC
Nitrogen; Para Hydrogen; Solvation; Quantum Mechanics; Infrared Spectroscopy; Argon; Doping (Materials)

20030061344 Air Force Research Lab., Edwards AFB, CA, USA
Characterization of Reduced Toxicity, High Performance Monopropellants at the U.S. Air Force Research Laboratory
Hawkins, T. W.; Brand, A. J.; McKay, M. B.; Ismail, I. M. K.; Jun. 11, 2001; 10 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A411102; AFRL/PRS-ED-TP-2001-137; No Copyright; Avail: CASI; A02, Hardcopy

Current U.S. Air Force programs are working to develop reduced toxicity monopropellant formulations to replace spacecraft hydrazine monopropellant and exceed the monopropellant performance objective (greater than 50\% increase in density impulse) specified by the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program. The creation of such monopropellants can offer considerable cost savings associated with handling and loading, longer spacecraft service life, smaller vehicle design, and heavier payloads. The Air Force Research Laboratory's (AFRL) approach to replacing hydrazine is the development of energetic liquid salt mixtures with substantially less vapor toxicity and superior performance (specific impulse and density). These liquid salt mixtures show promise as one avenue toward replacement of hydrazine monopropellant. During the last year, work has centered on the production and characterization of a few of these reduced toxicity monopropellant formulations. Aside from a low melting point and toxicity, there are a number of properties that are desirable for a monopropellant successor to hydrazine. This report presents the results of tests of specific properties of a new monopropellant (AFN1) that is under investigation by AFRL and compared them to hydrazine. Experimental results are provided for density, vapor toxicity, carbon content of exhaust, melting point, detonability, friction and impact sensitivity, Adiabatic compressibility, thermal stability, critical diameter, viscosity, velocity, and theoretical performance with regard to specific impulse, density, volumetric impulse, and detonation velocity. The report also provides thruster test results for AFN1 and hydrazine in the following areas: theoretical, measured, and efficiency of catalytic decomposition at 64\% ammonia dissociation; chamber pressure; throughput; and pulse duration. (6 tables, 2 figures, 5 refs.)
DTIC
High Energy Propellants; Space Propulsion; Monopropellants; Toxicity

20030061366 Air Force Research Lab., Edwards AFB, CA, USA
Design of New Materials Using CCM: Materials by Design CHSSI Portfolio -01
Boatz, Jerry; Jun. 2002; 31 pp.; In English
Contract(s)/Grant(s): AF Proj. 2303
Report No.(s): AD-A411292; AFRL-PR-ED-VG-2002-119; No Copyright; Avail: CASI; A03, Hardcopy

Viewgraphs for presentation on the design of new propellant, high energy, absorbing, and polymer materials using computational chemistry and materials science (CCM) methods.
DTIC
Computational Chemistry; Materials Science; Propellants; High Polymers

20030061373 Air Force Research Lab., Edwards AFB, CA, USA
On a Quantitative Scale for Lewis Acidity and Recent Progress in Polynitrogen Chemistry
Christe, Karl O.; Dixon, David A.; McLemore, Douglas; Wilson, William W.; Sheehy, Jeffrey A.; May 27, 1999; 9 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A411235; AFRL-PR-ED-TP-FY99-0119; No Copyright; Avail: CASI; A02, Hardcopy

A quantitative scale for Lewis acidities based on fluoride ion affinities is discussed. It uses pH values which represent the fluoride ion affinities in kcal/mol divided by 10. These values were obtained for 106 Lewis acids in a self-consistent manner using ab initio calculations at the MP2/PDZ level of theory. In the area of polynitrogen chemistry, the synthesis and characterization of the novel N(5+) cation from N2F(+) and HN3 is described.
DTIC
Nitrogen Compounds; Synthesis (Chemistry); Acidity; Fluorides; Polymers

20030061401 Woods Hole Oceanographic Inst., MA, USA
Characterization of the Structural and Chemical Properties of Copper Chelators in Marine Systems
Moffett, James W.; Frew, Nelson M.; February 2003; 10 pp.; In English
Contract(s)/Grant(s): N00014-99-1-0033
Report No.(s): AD-A411273; WHOI-P-13003300; No Copyright; Avail: CASI; A02, Hardcopy

Copper speciation in seawater is generally dominated by low concentrations of strong, highly selective Cu chelators. At present, we have no data to account for the high specificity and high binding affinity of these compounds for Cu, nor can we validate hypotheses regarding their sources and sinks. We propose to study the structural and chemical properties of strong Cu chelators produced by a ubiquitous marine cyanobacterium, Synechococcus sp., a plausible source of strong Cu chelators in seawater. We plan to characterize these compounds using high performance liquid chromatography (HPLC) and electrospray ionization mass spectrometry (ESI-MS), coupled with electrochemical methods currently used to study Cu binding. Dr. James Moffett studies Cu speciation and phytoplankton interactions in seawater and Dr. Nelson Frew is an environmental organic chemist and mass spectroscopist. Such interdisciplinary collaboration is absolutely essential for the proposed work. Results will be used to explain the unique properties of these compounds, which may be important in Cu detoxification. Very few commercially available chelators exhibit the selectivity for Cu displayed by these chelators, suggesting a physiological function. It is possible that these compounds or synthetic analogues may be useful for remediation of Cu contaminated wastewaters, or other processes relevant to the U.S. Navy. Results will also be useful in developing field assays for chelators present in the water column. Such assays are essential in establishing causal links between the accumulation of Cu chelators in seawater and detoxification mechanisms of the biota.
DTIC
Chemical Properties; Copper; Bacteria; Marine Biology; Chemical Analysis

20030061410 Naval Postgraduate School, Monterey, CA
Passive Detection of Gases in the Atmosphere. Case Study: Remote Sensing of SO(2) in the UV Using LINUS
Halvatzis, Anastasios G.; Dec. 2002; 135 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411319; No Copyright; Avail: CASI; A07, Hardcopy

An imaging UV spectrometer was used to study sulfuric plumes at Lassen Volcanic National Park, in an effort to identify and quantify SO presence. The NPS instrument, LINUS (Lineate Imaging Near -Ultraviolet Spectrometer), was taken to Lassen on September 13 and 14, 2002. Data taken there are compared to laboratory measurements of SO(2) subsequently run at NPS. These data, along with additional measurements of platinum discharges for wavelength calibration, allow for comparison with atmospheric modeling calculations. Observations were modeled with the standard MODTRAN code. Comparisons between stimulated and measured data showed minor indications of SO(2) in the Lassen data. The gas concentration was estimated to be less than 10ppmv.
DTIC
Ultraviolet Spectrometers; Imaging Techniques; Detection; Gases; Remote Sensing; Atmospheric Models

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METALS AND METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals and metallic materials; and metallurgy.

20030059520 Air Force Inst. of Tech., Wright-Patterson AFB, OH
Crack Growth in Alloy 718 Under Thermal-Mechanical Cycling
Heil, Michael L.; Dec. 1986; 183 pp.; In English
Report No.(s): AD-A412470; AFIT/DS/AA/86-1; No Copyright; Avail: CASI; A09, Hardcopy

An investigation was conducted to evaluate and model the crack growth rates in a nickel-base super-joy under load controlled thermal-mechanical cycling. Experiments were conducted on center-cracked panel specimens of Inconel 718 with temperature limits of 427 C to 649 C. closed-loop temperature control in the cracked region of the specimen was maintained by a microcomputer and four quartz heating lamps. A D.C. electric potential drop method was used to monitor crack lengths. The elastic stress intensity factor, K, was used to correlate all crack growth data.& A linear cumulative damage model was developed which sums cycle-dependent, mixed-mode, and time-dependent damage terms to predict thermal-mechanical fatigue crack growth rates. The model was developed entirely from isothermal baseline test data. The cycle-dependent term was based on low temperature (427 C) high frequency (10 Hz) crack growth data. The mixed-mode term was developed from low frequency (0.01 Hz) fatigue crack growth tests at 538 C and 649 C. The time-dependent term was developed from sustained-load crack growth tests at 538 C, 593 C, and 649 C. All thermal and mechanical cycles used during thermal-mechanical fatigue (TMF) testing were symmetric, triangular, and 96 seconds long. Crack growth rates were determined over a range of Sigma K using a stress ratio, R, of 0.1. Tests were conducted with the maximum load leading the maximum temperature by phase angles of 0, 90\%, 180, 225, 270, and 315. The in-phase test (0') produced the highest crack growth rates, with the 315', 270', 225', 180', and 90' tests following in order. The 0' and 90' crack growth rates were separated by over a factor of ten at all AK values tested.% All TMF crack growth rates were bracketed by the isothermal growth rates at 427 C and 649 C.
DTIC
Elastic Properties; Crack Propagation; Thermal Fatigue; Fatigue Tests

20030059526 Korea Univ., Seoul, Korea, Republic of
Analytical Models for Predicting Mechanical Properties of Self-Expandable Metal Stents with Cover Membrane
Moon, T.; Hong, D.; Chun, H. J.; Hyun, J. H.; Lee, K. B.; Oct. 25, 2001; 5 pp.; In English; 23rd Annual International Conference of the IEEE engineering in Medicine and Biology Society, October 25-28, 2001, Istanbul, Turkey
Report No.(s): AD-A409480; X5-X5; No Copyright; Avail: CASI; A01, Hardcopy

Various mechanical characteristics of stents were analyzed and mathematical models were developed in order to predict expansive pressure of stents. Given the geometry and material properties of a stent, one can utilize these models to predict its expansive pressure properties. Then, these models were verified with the test results derived from some prototype and commercially available stents. The models allow for the characterization of mechanical properties of stents and may be instrumental in developing clinically efficacious stents.
DTIC
Mathematical Models; Mechanical Properties; Membranes; Clinical Medicine; Metals

20030060461 Michigan Univ., Ann Arbor, MI, Defense Advanced Research Projects Agency, Arlington, VA, USA
Massively Parallel Post-Packaging for Microelectromechanical Systems (MEMS)
Lin, Liwei; Wise, Kensall; Mar. 2003; 68 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F30602-98-2-0227; Proj-E117
Report No.(s): AD-A412517; AFRL-IF-RS-TR-2003-48; No Copyright; Avail: CASI; A04, Hardcopy

This project has achieved many accomplishments toward 'Massively Parallel Post-Packaging for MEMS.' These achievements can be summarized as follows: (1) innovative bonding processes; (2) post-fabrication packaging demonstrations and characterizations on various MEMS devices; and (3) demonstrations and characterizations of post-fabrication device trimming. In summary, we were able to develop several new localized bonding processes, including eutectic bonding, fusion bonding, solder bonding, chemical vapor deposition (CVD) bonding, nano-second laser welding, inductive heating and bonding, ultrasonic bonding and rapid thermal processing (RTP) bonding. Every bonding process represents technology innovation and advancement. In addition, new material bonding systems were also investigated and established. These include aluminum-to-glass, aluminum-to-nitride, and aluminum-to-aluminum bonding systems. The new bonding processes and

systems make possible the device encapsulation demonstrations, such as vacuum encapsulated micro resonators, by using localized aluminum-to-glass bonding, RTP bonding and localized CVD bonding. These vacuum bonded devices have gone through various types of characterization, including quality factor measurements, long-term stability monitoring and accelerated tests. In another device packaging area, selective trimming of micro resonators was successfully demonstrated by three different schemes, including active trimming by a localized heating and stressing effect, permanent trimming by localized CVD deposition and by pulsed laser deposition.
DTIC
Bonding; Vapor Deposition

20030060475 Princeton Univ., NJ, USA
Multifunctional Mechatronic Materials
Evans, Anthony; Feb. 21, 2003; 250 pp.; In English
Contract(s)/Grant(s): N00014-00-1-0885; Proj-PR03303
Report No.(s): AD-A411734; No Copyright; Avail: CASI; A11, Hardcopy

Contributions have been made in two basic areas: ultralight structures based on sandwich panels with truss and textile cores, and high authority actuating structures based on the properties of the Kagome system. This final report contains the following studies: (1) Effective Properties of the Octet-truss Lattice Material, by V.S. Deshpande, N.A. Fleck, and M.F. Ashby; (2) Kagome Plate Structures for Actuation, by R.G. Hutchinson, N. Wicks, A.G. Evans, N.A. Fleck, and J.W. Hutchinson; (3) Measurements and Simulations of the Performance of Metallic Sandwich Structures with a Near Optimal Tetrahedral Truss Core, by H.J. Rathbun, Z. Wei, M.Y. He, F.W. Zok, and A.G. Evans; (4) Minimum Weight Design of a High Authority Flexural Actuator Based on Electroelastomers, by L.H. Han, T.J. Lu, and A.G. Evans; (5) Optimal Truss Plates, by N. Wicks and J.W. Hutchinson; (6) On the Performance of Light Weight Metallic Panels Fabricated Using Textile Technology, by D.R. Mumm, S. Chiras, A. G. Evans, J.W. Hutchinson, and D.J. Sypeck, et al.; (7) Performance of Sandwich Plates with Truss Cores, by N. Wicks and J.W. Hutchinson; and (8) The Structural Performance of Near-Optimized Truss Core Panels, by S. Chiras, D.R. Mumm, A.G. Evans, N.Wicks, and J.W. Hutchinson, et al.
DTIC
Sandwich Structures; Composite Materials; Mechanical Engineering; Crystal Lattices; Textiles; Fabrication

20030060501 New Jersey Inst. of Tech., University Heights, NJ, USA
Experimental Technique for the Study of High-Temperature Phase Equilibria in Reactive Molten Metal Based Systems
Ermoline, Alexandre; Schoenitz, Mirko; Dreizin, Edward; 2002 Microgravity Materials Science Conference; February 2003, pp. 178-187; In English; See also 20030060494; No Copyright; Avail: CASI; A02, Hardcopy

An apparatus for containerless experiments under microgravity conditions onboard the KC-135 aircraft for the study of high-temperature phase equilibria in molten-metal based systems has been designed and built. The estimates show that mm-sized samples can be heated and equilibrated during one parabolic trajectory of the KC-135 aircraft. This size is also sufficient for subsequent phase analysis (SEM, TEM, XRD). Preliminary tests in normal gravity using samples suspended on a ceramic fiber are used to develop the electronic control and data acquisition system.
Author
Spaceborne Experiments; Metal Oxides; Equilibrium; Phase Transformations; Reaction Kinetics; Refractory Materials; Acoustic Levitation

20030060514 NASA Marshall Space Flight Center, Huntsville, AL, USA
Structural Fluctuations and Thermophysical Properties of Molten II-VI Compounds
Su, Ching-Hua; Zhu, Shen; Li, Chao; Scripa, R.; Lehoczky, Sandra L.; Kim, Y. W.; Baird, J. K.; Lin, B.; Ban, Heng; Benmore, Chris; 2002 Microgravity Materials Science Conference; February 2003, pp. 604-611; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

The objectives of the project are to conduct ground-based experimental and theoretical research on the structural fluctuations and thermophysical properties of molten II-VI compounds to enhance the basic understanding of the existing flight experiments in microgravity materials science programs as well as to study the fundamental heterophase fluctuation phenomena in these melts by: 1) conducting neutron scattering analysis and measuring quantitatively the relevant thermophysical properties of the II-VI melts (such as viscosity, electrical conductivity, thermal diffusivity and density) as well as the relaxation characteristics of these properties to advance the understanding of the structural properties and the relaxation phenomena in these melts and 2) performing theoretical analyses on the melt systems to interpret the experimental results. All

the facilities required for the experimental measurements have been procured, installed and tested. It has long been recognized that liquid Te presents a unique case having properties between those of metals and semiconductors. The electrical conductivity for Te melt increases rapidly at melting point, indicating a semiconductor-metal transition. Te melts comprise two features, which are usually considered to be incompatible with each other: covalently bound atoms and metallic-like behavior. Why do Te liquids show metallic behavior? is one of the long-standing issues in liquid metal physics. Since thermophysical properties are very sensitive to the structural variations of a melt, we have conducted extensive thermophysical measurements on Te melt.

Author

Thermophysical Properties; Liquid Metals; Alkaline Earth Compounds; Group 6a Compounds

20030060518 Northwestern Univ., USA

The Evolution of Dendrite Morphology during Isothermal Coarsening

Alkemper, Jens; Mendoza, Roberto; Kammer, Dimitris; Voorhees, Peter W.; 2002 Microgravity Materials Science Conference; February 2003, pp. 26-32; In English; See also 20030060494; Original contains color and black and white illustrations

Contract(s)/Grant(s): NAG8-1660; No Copyright; Avail: CASI; A02, Hardcopy

Dendrite coarsening is a common phenomenon in casting processes. From the time dendrites are formed until the inter-dendritic liquid is completely solidified dendrites are changing shape driven by variations in interfacial curvature along the dendrite and resulting in a reduction of total interfacial area. During this process the typical length-scale of the dendrite can change by orders of magnitude and the final microstructure is in large part determined by the coarsening parameters. Dendrite coarsening is thus crucial in setting the materials parameters of ingots and of great commercial interest. This coarsening process is being studied in the Pb-Sn system with Sn-dendrites undergoing isothermal coarsening in a Pb-Sn liquid. Results are presented for samples of approximately 60\% dendritic phase, which have been coarsened for different lengths of times. Presented are three-dimensional microstructures obtained by serial-sectioning and an analysis of these microstructures with regard to interface orientation and interfacial curvatures. These graphs reflect the evolution of not only the microstructure itself, but also of the underlying driving forces of the coarsening process. As a visualization of the link between the microstructure and the driving forces a three-dimensional microstructure with the interfaces colored according to the local interfacial mean curvature is shown.

Author

Dendritic Crystals; Isothermal Processes; Directional Solidification (Crystals); Liquid-Solid Interfaces; Morphology

20030060521 Arizona Univ., AZ, USA

Comparison of Structure and Segregation in Alloys Directionally Solidified in Terrestrial and Microgravity Environments

Poirier, D. R.; Heinrich, J. C.; Tewari, S. N.; 2002 Microgravity Materials Science Conference; February 2003, pp. 452-463; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The research is technologically important because it is directly relevant to a casting process used to make critical components that are used in high temperature gas turbine engines in aircraft and land-based power generators. The science learned in this program will enable engineers to better control this important casting process. The grant is a Flight Definition Program, so efforts have been on preparation to eventually conduct long duration experiments in microgravity. The primary purpose is to compare the structure and segregation in a metallic alloy that is directionally solidified in a terrestrial environment (subject to convection) to the same alloy solidified in microgravity. Thermosolutal convection masks the effects of diffusional transport during solidification and also leads to macrosegregates known as freckles; hence, in terrestrial experiments, diffusive and convective phenomena occur simultaneously, which complicate the study of dendritic growth. In microgravity, however, it would be possible to effect directional solidification with no thermosolutal convection. Our hypotheses are the convection and attendant macrosegregation will be eliminated and the dendritic microstructure will be greatly altered in microgravity. Availability of microgravity provides an opportunity to obtain experimental data, where thermosolutal convection is negligible.

Derived from text

Directional Solidification (Crystals); Microgravity; Mathematical Models; Casting; Microstructure; Alloys; Separation

20030060538 Virginia Commonwealth Univ., Richmond, VA, USA

Metallic and Intermetallic Nanoparticle Filaments and Tree-Like Assemblies Prepared by Laser Vaporization Controlled Condensation

Abdelsayed, V.; Al-Sharaeh, E.; El-Shall, M. S.; 2002 Microgravity Materials Science Conference; February 2003, pp. 210; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Nanoparticles exhibit interesting properties that are usually different from the bulk materials properties. The evolution of the nanoscale properties is largely dependent on the size, shape and assembly of the nanoparticles. The general objective of the ground-based experiments is to advance the scientific understanding of nucleation and materials synthesis from the vapor phase, which are strongly influenced by gravity and convection effects. In this work, we present a method to synthesize size-selected nanoparticles of a variety of materials by coupling the laser vaporization controlled condensation (LVCC) technique with a differential mobility analyzer (DMA). The LVCC method is based on using pulsed laser vaporization within well-defined conditions of temperature and pressure in a thermal diffusion cloud chamber. The coupling of LVCC and DMA is applied to synthesize Al, Fe, Ni, Ti and FeAl intermetallic nanoparticles of selected sizes. The LVCC method can be coupled to plasma and ionic polymerization techniques, thus allowing the incorporation of the metallic nanoparticles within the polymer films. The size of the product polymer particles is limited in normal gravity by gravitational settling. The application of microgravity to the study of gas phase polymerization is expected to result in a better control of the process and may also lead to important technological advances. The effect of electrical charging of the nanoparticles by ions and free electrons generated by the laser vaporization process has been investigated. Enormous electrostatic aggregation due to dipole forces is observed between nanoparticles to form chain aggregates, and between the chain aggregates to form tree-like filaments. The tree-like aggregates may have special applications as fillers or additives to increase the elastic modulus and tensile strength of polymers such as low strength rubbers. These materials could have unique properties and may lead to new practical and technological applications.

Author

Intermetallics; Lasers; Nanoparticles; Vaporizing; Filaments; Metals; Condensates

20030060546 Arizona Univ.

Kinetic Monte Carlo Simulations of Rod Eutectics and the Surface Roughening Transition in Binary Alloys

Bentz, Daniel N.; Betush, William; Jackson, Kenneth A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 289-297; In English; See also 20030060494; Original contains color and black and white illustrations

Contract(s)/Grant(s): NAG8-1667; No Copyright; Avail: CASI; A02, Hardcopy

In this paper we report on two related topics: Kinetic Monte Carlo simulations of the steady state growth of rod eutectics from the melt, and a study of the surface roughness of binary alloys. We have implemented a three dimensional kinetic Monte Carlo (kMC) simulation with diffusion by pair exchange only in the liquid phase. Entropies of fusion are first chosen to fit the surface roughness of the pure materials, and the bond energies are derived from the equilibrium phase diagram, by treating the solid and liquid as regular and ideal solutions respectively. A simple cubic lattice oriented in the {100} direction is used. Growth of the rods is initiated from columns of pure B material embedded in an A matrix, arranged in a close packed array with semi-periodic boundary conditions. The simulation cells typically have dimensions of 50 by 87 by 200 unit cells. Steady state growth is compliant with the Jackson-Hunt model. In the kMC simulations, using the spin-one Ising model, growth of each phase is faceted or nonfaceted phases depending on the entropy of fusion. There have been many studies of the surface roughening transition in single component systems, but none for binary alloy systems. The location of the surface roughening transition for the phases of a eutectic alloy determines whether the eutectic morphology will be regular or irregular. We have conducted a study of surface roughness on the spin-one Ising Model with diffusion using kMC. The surface roughness was found to scale with the melting temperature of the alloy as given by the liquidus line on the equilibrium phase diagram. The density of missing lateral bonds at the surface was used as a measure of surface roughness.

Author

Binary Alloys; Eutectic Alloys; Monte Carlo Method; Rods; Steady State; Surface Roughness; Simulation; Kinetics

20030060548 California Inst. of Tech., Pasadena, CA, USA

Studies of Properties of Undercooled Glass Forming Metallic Alloys

Johnson, W. L.; Schroers, J.; Rhim, W. K.; 2002 Microgravity Materials Science Conference; February 2003, pp. 307-310; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A01, Hardcopy

Bulk metallic glass forming liquids are metal alloys which exhibit a high degree of resistance to nucleation and growth

of crystals. Such alloys can be processed for laboratory time scales in the deeply undercooled liquid state. This has made studies of thermophysical properties of these liquids from the equilibrium melt down to the glass transition temperature of the undercooled melt. Of particular interest is the study viscosity and atomic diffusion in these glass forming liquids. These properties are of particular interest as they relate to fundamental theories of the glass transition in liquids, (e.g. Beta-Relaxations, Mode-Coupling Theory, Liquid Fragility, etc.) High Vacuum Electostatic Levitation (HVESL) Processing offer a platform for study liquids under high vacuum, containerless, and quiescent conditions. Using a NASA supported ESL facility located at Caltech, we have developed a method for laser heating and melting of spherical liquid drops under high vacuum conditions using a newly developed high symmetry 4-beam tetrahedral laser heating system. The liquid drop is melted, stably positioned, and subsequently brought to chosen temperature under very near isothermal conditions. Using symmetic heating, a 3mm sphere can be maintained at 1000 K with total temperature variations of order or less than 0.1 K over the sphere. Under such conditions, both gravity driven and Marangoni convection within the liquid sphere can be minimized. Steady state convective flow velocities of microns per second and less can be achieved. The liquid thus exhibits benchmark levels of quiescence. The near quiescence of the liquid allows, for the first time, direct measurements of intrinsic atomic diffusion constants and impurity diffusion constants in the liquid without contamination of the data by convection. The diffusants are deposited from the gas phase onto the surface of the levitated liquid drop and allowed to diffuse into the sphere. Depth profiles of the diffusant in the sphere are captured by relatively rapid quenching the sample from the measurement temperature to ambient and are later analyzed to obtain diffusion constants for the molten alloys. Under microgravity conditions, g-driven convection can be mitigated still further to yield benchmark atomic diffusion measurements in liquids which are essentially free of convective contamination effects. In addition to development of the HVESL platform with symmetric laser heating, the present project includes direct measurements and modeling of the temperature distributions in the liquid drop, modeling of Marangoni and g-driven convective flows, and comparison of models with with experimental results for actual samples processed in the ground-based Caltech HVESL using symmetric heating. HVESL data on actual glass forming liquids has been obtained to determine time-temperature-processing windows for liquid diffusion studies in the shallow and deeply undercooled regimes of several glass forming alloys. Using a combination of experiments and modeling, we have established a processing parameter matrix which demonstrates the window of opportunity in which convection-free atomic diffusion studies can be carried out.

Author

Metallic Glasses; Alloys; Particle Diffusion; Levitation Melting; Thermophysical Properties; Levitation; Viscosity

20030060557 Illinois Univ., Chicago, IL, USA

Investigation of Dynamic Oxygen Adsorption in Molten Solder Jetting Technology

Megaridis, Constantine M.; Bellizia, Giulio; McNallan, Michael; Wallace, David B.; 2002 Microgravity Materials Science Conference; February 2003, pp. 418-426; In English; See also 20030060494; Original contains black and white illustrations Contract(s)/Grant(s): NAG8-1473; No Copyright; Avail: CASI; A02, Hardcopy

Surface tension forces play a critical role in fluid dynamic phenomena that are important in materials processing. The surface tension of liquid metals has been shown to be very susceptible to small amounts of adsorbed oxygen. Consequently, the kinetics of oxygen adsorption can influence the capillary breakup of liquid-metal jets targeted for use in electronics assembly applications, where low-melting-point metals (such as tin-containing solders) are utilized as an attachment material for mounting of electronic components to substrates. By interpreting values of surface tension measured at various surface ages, adsorption and diffusion rates of oxygen on the surface of the melt can be estimated. This research program investigates the adsorption kinetics of oxygen on the surface of an atomizing molten-metal jet. A novel oscillating capillary jet method has been developed for the measurement of dynamic surface tension of liquids, and in particular, metal melts which are susceptible to rapid surface degradation caused by oxygen adsorption. The experimental technique captures the evolution of jet swells and necks continuously along the jet propagation axis and is used in conjunction with an existing linear, axisymmetric, constant-property model to determine the variation of the instability growth rate, and, in turn, surface tension of the liquid as a function of surface age measured from the exit orifice. The conditions investigated so far focus on a time window of 2-4ms from the jet orifice. The surface properties of the eutectic 63\%Sn-37\%Pb solder alloy have been investigated in terms of their variation due to O2 adsorption from a N2 atmosphere containing controlled amounts of oxygen (from 8 ppm to 1000 ppm). The method performed well for situations where the oxygen adsorption was low in that time window. The value of surface tension for the 63Sn-37Pb solder in pure nitrogen was found to be 0.49 N/m, in good agreement with previously published work. A characteristic time of O(1ms) or less was determined for the molten-metal surface to be saturated by oxygen at 1000 ppm concentration in N2.

Author

Interfacial Tension; Solders; Adsorption; Reaction Kinetics; Surface Diffusion; Liquid Metals

20030060562 Arizona Univ., USA

Comparison of Structure and Segregation in Alloys Directionally Solidified in Terrestrial and Microgravity Environments

Poirier, D. R.; Heinrich, J. C.; Tewari, S. N.; 2002 Microgravity Materials Science Conference; February 2003, pp. 452-463; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The research is technologically important because it is directly relevant to a casting process used to make critical components that are used in high temperature gas turbine engines in aircraft and land-based power generators. The science learned in this program will enable engineers to better control this important casting process. The grant is a Flight Definition Program, so efforts have been on preparation to eventually conduct long duration experiments in microgravity. The primary purpose is to compare the structure and segregation in a metallic alloy that is directionally solidified in a terrestrial environment (subject to convection) to the same alloy solidified in microgravity. Thermosolutal convection masks the effects of diffusional transport during solidification and also leads to macrosegregates known as freckles; hence, in terrestrial experiments, diffusive and convective phenomena occur simultaneously, which complicate the study of dendritic growth. In microgravity, however, it would be possible to effect directional solidification with no thermosolutal convection. Our hypotheses are the convection and attendant macrosegregation will be eliminated and the dendritic microstructure will be greatly altered in microgravity. Availability of microgravity provides an opportunity to obtain experimental data, where thermosolutal convection is negligible. Terrestrial solidification experiments on Pb-Sb alloys have been done using different growth conditions to effect different dendritic microstructures. Numerical modeling to simulate the transport phenomena and solidification of the planned experiments and terrestrial experiments are continuing in order to define growth conditions for microgravity experiments. Theoretical models of dendritic solidification rely on the assumption of only diffusional effects, but, on earth, convection is important and may mask the diffusional effects. Thus, from a scientific point of view, it is important to compare the characteristics of directional solidification in both environments. Also attempts to measure the diffusivity of Sb in Pb melts have been done because it is needed to validate dendritic growth models. Pb-2.2 %Sb samples were solidified in 1, 2, and 3 mm ID quartz capillaries at 82 K/cm and 0.4 m/s. Precautions to avoid vibrations and to achieve a rapid quench in He were effected. It was found that employment of ampoule diameters as small as 1 mm cannot eliminate the convection. Calculations indicate that capillaries of less than 0.6 mm may be needed. A finite element model for predicting cellular and dendritic growth forms has also been under development. The numerical model has been tested in a number of scenarios, including the dendritic solidification of hypoeutectic Pb-Sb alloys (2.2 and 5.5 %Sb) under realistic thermal conditions.
Author

Dendritic Crystals; Crystal Growth; Directional Solidification (Crystals); Alloys; Microgravity; Microstructure; Phase Transformations

20030060573 Massachusetts Inst. of Tech., MA, USA

From Oxygen Generation to Metals Production: In Situ Resource Utilization by Molten Oxide Electrolysis

Khetpal, Deepak; Ducret, Andrew C.; Sadoway, Donald R.; 2002 Microgravity Materials Science Conference; February 2003, pp. 548-555; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

For the exploration of other bodies in the solar system, electrochemical processing is arguably the most versatile technology for conversion of local resources into usable commodities: by electrolysis one can, in principle, produce (1) breathable oxygen, (2) silicon for the fabrication of solar cells, (3) various reactive metals for use as electrodes in advanced storage batteries, and (4) structural metals such as steel and aluminum. Even so, to date there has been no sustained effort to develop such processes, in part due to the inadequacy of the database. The objective here is to identify chemistries capable of sustaining molten oxide electrolysis in the cited applications and to examine the behavior of laboratory-scale cells designed to generate oxygen and to produce metal. The basic research includes the study of the underlying high-temperature physical chemistry of oxide melts representative of lunar regolith and of Martian soil. To move beyond empirical approaches to process development, the thermodynamic and transport properties of oxide melts are being studied to help set the limits of composition and temperature for the processing trials conducted in laboratory-scale electrolysis cells. The goal of this investigation is to deliver a working prototype cell that can use lunar regolith and Martian soil to produce breathable oxygen along with metal by-product. Additionally, the process can be generalized to permit adaptation to accommodate different feedstock chemistries, such as those that will be encountered on other bodies in the solar system. The expected results of this research include: (1) the identification of appropriate electrolyte chemistries; (2) the selection of candidate anode and cathode materials compatible with electrolytes named above; and (3) performance data from a laboratory-scale cell producing oxygen and metal. On the strength of these results it should be possible to assess the technical viability of molten oxide electrolysis for in situ resource utilization on the Moon and Mars. In parallel, there may be commercial applications here on earth, such as new green

technologies for metals extraction and for treatment of hazardous waste, e.g., fixing heavy metals.
Author
In Situ Resource Utilization; Electrolysis; Heavy Metals; Melts (Crystal Growth); Oxygen; Molten Salts

20030060688 United Space Alliance, Cape Canaveral, FL, USA
The Use af Ion Vapor Deposited Aluminum (IVD) for the Space Shuttle Solid Rocket Booster (SRB)
Novak, Howard L.; [2002]; 1 pp.; In English; 13th Annual International Workshop on Solvent Substitution and Elimination of Toxic Substances, 9-12 Dec. 2002, Scottsdale, AZ, USA
Contract(s)/Grant(s): NAS8-2000; No Copyright; Avail: Other Sources; Abstract Only

The USA LLC Materials & Processes (M&P) Engineering Department had recommended the application and evaluation of Ion Vapor Deposition (IVD) aluminum to SRB Hardware for corrosion protection and elimination of hazardous materials and processes such as cadmium plating. IVD is an environmentally friendly process that has no volatile organic compounds (VOCs), or hazardous waste residues. It lends itself to use with hardware exposed to corrosive seacoast environments as found at Kennedy Space Center (KSC), and Cape Canaveral Air Force Station (CCAFS), Florida. Lifting apparatus initially coated with cadmium plating for corrosion protection; was stripped and successfully re-coated with IVD aluminum after the cadmium plating no longer protected the GSE from corrosion, Since then, and after completion of a significant test program, the first flight application of the IVD Aluminum process on the Drogue Parachute Ratchet Assembly is scheduled for 2002.
Author
Corrosion Prevention; Vapor Deposition; Protective Coatings; Aluminum

20030061078 Boeing Co., Saint Louis, MO, USA
Aging Optimization of Aluminum-Lithium Alloy C458 for Application to Cryotank Structures
Sova, B. J.; Sankaran, K. K.; Babel, H. W.; Farahmand, B.; Rioja, R.; [2003]; 16 pp.; In English; AeroMat 2003, 9-12 Jun. 2003, Dayton, OH, USA; Copyright; Avail: CASI; A03, Hardcopy

This viewgraph report presents an examination of the fracture toughness of aluminum-lithium alloy C458 for use in cryotank structures. Topics cover include: cryogenics, alloy composition, strengthing precipitates in C458, cryogenic fracture toughness improvements, design of experiments for measuring aging optimization of C458 plate and effects of aging of properties of C458 plate.
CASI
Fracture Strength; Aluminum-Lithium Alloys; Aging (Materials); Tanks (Containers); Cryogenics; Tensile Properties

20030061082 NASA Marshall Space Flight Center, Huntsville, AL, USA
Alkali Metal Handling Practices at NASA MSFC
Salvail, Patrick G.; Carter, Robert R.; December 06, 2002; 5 pp.; In English; Space Technology and Applications International Forum, 2-5 Feb. 2003, Albuquerque, NM, USA
Contract(s)/Grant(s): NSI-090-50-T2; No Copyright; Avail: CASI; A01, Hardcopy

NASA Marshall Space Flight Center (MSFC) is NASA s principle propulsion development center. Research and development is coordinated and carried out on not only the existing transportation systems, but also those that may be flown in the near future. Heat pipe cooled fast fission cores are among several concepts being considered for the Nuclear Systems Initiative. Marshall Space Flight Center has developed a capability to handle high-purity alkali metals for use in heat pipes or liquid metal heat transfer loops. This capability is a low budget prototype of an alkali metal handling system that would allow the production of flight qualified heat pipe modules or alkali metal loops. The processing approach used to introduce pure alkali metal into heat pipe modules and other test articles are described in this paper.
Author
Alkali Metals; Heat Pipes; Transportation; Liquid Metals

20030061092 NASA Marshall Space Flight Center, Huntsville, AL, USA
New Experiments with Spinning Metallic Discs
Mazuruk, Konstantin; Grugel, Richard N.; [2003]; 1 pp.; In English; Space Technology and Applications International Forum (STAIF-2003), 2-6 Feb. 2003, Albuquerque, NM, USA; No Copyright; Avail: Other Sources; Abstract Only

A number of recent advanced theories related to torsion properties of the space-time matrix predict the existence of an interaction between classically spinning objects. Indeed, some experimental data suggest that spinning magnetic bodies discernibly interact with Earth's natural fields. If there are interactions between rotating bodies then nuclear spins could be

used for detection. Thus, assuming a spinning body induces a hypothetical torsion field, a sensor based on the giant magnetoresistance effect would detect local changes. Experimentally, spinning a brass wheel shielded from Earth's magnetic field showed no measurable change in signals; with no shielding a Faraday disc phenomenon was observed. Unexpected experimental measurements from the non-axial Faraday disc configuration were recorded and a theoretical model was derived to explain them.
Author
Geomagnetism; Nuclear Spin; Magnetoresistivity; Torsion

20030061113 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
The Effect of a Hard Coating of the Damping and Fatigue Life of Titanium
Ivancic, Frank T.; Mar. 14, 2003; 148 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412854; AFIT/GAE/ENY/03-12; No Copyright; Avail: CASI; A07, Hardcopy

This project compares the damping and fatigue life of bare titanium plates to those coated with magnesium aluminate spinel (mag spinel). Two different coating thicknesses were tested: .005' per side and .010' per side (total thicknesses of .010' and .020'). Dynamic ping tests were conducted on all specimens to determine their resonance frequencies. Laser vibrometry was used to determine the mode at each resonance frequency. Damping ratios were determined through the use of sine sweeps. A vibration mode was selected at which to fatigue the specimens, and the stress pattern was analyzed utilizing the Stress Pattern Analysis by Thermal Emissions (SPATE) process. Once characterization was complete, fatigue testing was conducted on the thick plates utilizing the resonant dwell process. The specimens were vibrated by applying a harmonic excitation through the base. The strain level which would result in fatigue at 106 cycles, and the velocity necessary to achieve this strain were determined. The test specimens were excited at this velocity, and the number of cycles to failure was noted. Results were compared for the uncoated, thin coated, and thick coated specimens.
DTIC
Fatigue Life; Damping; Titanium

20030061116 Universal Energy Systems, Inc., Dayton, OH
Materials Processing Research and Development
Barker, Douglas R.; Goetz, Robert L.; Nov. 2001; 152 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F33615-96-C-5251; Proj-4347
Report No.(s): AD-A412695; AFRL-ML-WP-TR-2001-4177; No Copyright; Avail: CASI; A08, Hardcopy

Research during the contract dealt with several areas related to the processing of advanced aerospace materials: fracture and cavitation, microstructure evolution, texture evolution, and constitutive equations. Materials studied were alpha 2, gamma, and near gamma TiAl's, an orthorhombic TiAl alloy, Ti-6Al-4V, 2024 Al, a nanophase Al alloy, and a tungsten heavy alloy. Tensile and uniaxial compression tests were used, as was the ring test for interface friction and heat transfer tests. In addition to conventional processes, emerging processes such as ECAE and friction stir welding were used and modeled. Finite element modeling was employed to predict states of stress, strain, strain rate, and temperature as well as material flow and loads. New models were developed for crack and cavitation prediction. Microstructure evolution was modeled using analytical methods, and a CA model was developed for heterogeneous static and dynamic recrystallization. AFRL resources were united with private industry, DoD contractors, and other Federal facilities using CTeC, MAl, and various CRADA tasks involving 13 DoD and DOE contractors. MPL technicians conducted 3072 processing operations and tests, and designed, fabricated or installed the following tooling or equipment; salt pot, ECAE tooling, rapid heat treat stand, 1OOO-ton load cell, DS unit, 55 kip and 200 kip MTS tooling, spin mold casting device, and mothballed the isothermal chamber.
DTIC
Titanium Alloys; Titanium Aluminides

20030061174 NASA Marshall Space Flight Center, Huntsville, AL, USA
Isothermal Calorimetric Observations of the Affect of Welding on Compatibility of Stainless Steels with High-Test Hydrogen Peroxide Propellant
Gostowski, Rudy C.; December 19, 2002; 6 pp.; In English; No Copyright; Avail: CASI; A02, Hardcopy

Compatibility is determined by the surface area, the chemical constituency and the surface finish of a material. In this investigation exposed area is obviously not a factor as the welded samples had a slightly smaller surface than the unwelded, but were more reactive. The chemical makeup of welded CRES 316L and welded CRES 304L have been observed in the literature to change from the parent material as chromium and iron are segregated in zones. In particular, the ratio of chromium

to iron in CRES 316L increased from 0.260 to 0.79 in the heat affected zone (HAZ) of the weld and to 1.52 in the weld bead itself. In CRES 304L the ratio of chromium to iron increased from 0.280 to 0.44 in the HAZ and to 0.33 in the weld bead. It is possible that the increased reactivity of the welded samples and of those welded without purge gas is due to this segregation phenomenon. Likewise the reactivity increased in keeping with the greater roughness of the welded and welded without purge gas samples. Therefore enhanced roughness may also be responsible for the increased reactivity.
Derived from text
Hydrogen Peroxide; Propellants; Stainless Steels; Welding; Isothermal Processes; Heat Measurement

20030061196 Lehigh Univ., Bethlehem, PA
Evaluation of Residual Stresses and Their Influence on Distortion in the Decoiling and Welding Processes
Misiolek, Wojciech Z.; Kazanowski, Pawel; Aug. 2002; 34 pp.; In English
Contract(s)/Grant(s): N00014-00-1-0807
Report No.(s): AD-A412862; No Copyright; Avail: CASI; A03, Hardcopy

An analysis of de-coiling process is provided. The expression for equilibrium of internal stresses within de-coiled plate during welding was established. First simulations of the de-coiling process have been prepared using Finite Element Modeling technique. Experimental verification of numerical results has been performed. The experimental results are in very good agreement with the numerical results. More insight into the changes of the sample material during deformation was achieved by careful microstructural examination. The microhardness measurements were proposed as a new and fast method of indicating the position of the neutral plane within de-coiled plate. Based on literature review and results of performed analysis a set of general rules for assembling a large structure by welding from de-coiled plates was proposed. Based on that set it will be possible to predict de-coiled plate distortion during welding.
DTIC
Distortion; Microstructure; Residual Stress; Welding; Mathematical Models

20030061347 Metz Univ., France
Low-Velocity Spall Testing of TI-6AL-4V Alloy and New Spall Criterion Based on Mesoscale
Klepaczko, J. R.; Sep. 16, 2002; 3 pp.; In English
Contract(s)/Grant(s): N62558-02-M-5857
Report No.(s): AD-A411161; R/D-9314-AN-01; No Copyright; Avail: CASI; A01, Hardcopy

This Interim Report covers the contract period from June 17/2002 to Sept. 16/2002 (the first period of three months).The research in this Project is directed toward better understanding of the development of the local plastic fields occurring in mesoscale during spalling of Ti-6A1-4V alloy. The specimens in the form of disks of different thickness and DIA 57.0 mm have been delivered by AMSRL-WM-TA, APG Aberdeen, MD. Later, all specimens have been polished and measured in our Laboratory (LPMM). The plate-plate facility is in the stage of preparation. Since an observation on mesoscale is envisaged, more exactly, the surface topography after spall fracture will be analyzed, two new high resolution profilometers, one based on the light interferometry: WYKO NTl000 by VEECO and the second: MAHR profilometer, based on mechanical contact, have been put into operation. Both profilometers are equipped with a software which has been already tested. The software permits for a detailed analysis of 3D profiles. Preliminary analyses of the spall surfaces available after earlier experiments are in progress. The test results obtained for Ti-6Al-4V from experiments of shearing at high strain rates will be applied to identification of material constants in new temperature coupled constitutive relation.
DTIC
Spalling; Titanium Alloys; Vanadium Alloys; Mechanical Properties; Low Speed

27
NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials. For composite materials see *24 Composite Materials*.

20030060410 National Inst. of Standards and Technology, Gaithersburg, MD
Journal of Research of the National Institute of Standards and Technology, November-December 2002. Volume 107, No 6. Special Issue: Accuracy Barriers of Quantitative Electron Beam X-Ray Microanalysis
Dec. 31, 2002; 282 pp.; In English
Report No.(s): PB2003-104841; No Copyright; Avail: CASI; A13, Hardcopy

Contents include the following: Special Issue: Accuracy Barriers of Quantitative Electron Beam X-Ray Microanalysis; Uncertainty in Quantitative Electron Probe Microanalysis; Accurate Cross Sections for Microanalysis; Optimization of Wavelength Dispersive X-Ray Spectrometery Analysis Conditions; High Count Rate Electron Probe Microanalysis; Decomposition of Wavelength Dispersive X-Ray Spectra; Limitations to Accuracy in Extracting Characteristic Line Intensities from X-Ray Spectra; Averaging of Backscatter Intensities in Compounds; The Analysis of Particles at Low Accelerating Voltages (< or = kV) with Energy Dispersive X-Ray Spectroscopy (EDS); X-Ray Microanalysis in the Variable Pressure (Environmental) Scanning Electron Microscope; Barriers to Quantitative Electron Probe X-Ray Microanalysis for Low Voltage Scanning Electron Microscopy; The Microcalorimeter for Industrial Applications; Sample Preparation for Electron Probe Microanalysis-Pushing the Limits; Implications of Polishing Techniques in Quantitative X-Ray Microanalysis;
NTIS
Quantitative Analysis; Microanalysis; X Ray Analysis

20030060468 Commissariat a l'Energie Atomique, Paris
Conference on Assembly and Self-Assembly at the Interface of Biology, Chemistry and Physics
Halperin, A.; Kas, J.; Aug. 2001; 63 pp.; In English; Conference on Assembly and Self-Assembly at the Interface of Biology, Chemistry and Physics, 20-25 Aug. 2001, Ciocco, Italy
Contract(s)/Grant(s): N00014-01-1-1009
Report No.(s): AD-A412524; No Copyright; Avail: CASI; A04, Hardcopy

This report on the Conference on Assembly and Self-Assembly at the Interface of Biology, Chemistry, and Physics held in Il Ciocco, Italy, on August 20-25, 2001, includes an overview, the program, attendee list, and presentation abstracts. Recent advances, such as scanning probe microscopy, genetic approaches in molecular biology, optical traps, and single molecule microscopy and spectroscopy, created a natural interface between the worlds of chemistry, physics, and biology by exploring the nanometer scale. This is the fundamental length scale where novel mesoscopic materials confront the building blocks of life: proteins and DNA. These developments in nanoscience, together with visions of nanoengineering and lessons from cell and molecular biology define a current challenge: manufacturing complex, heterogeneous structures of well-controlled architecture and function. The attainment of this objective requires a deeper knowledge of assembly and self-assembly (ASA) as encountered in biology, chemistry, and physics. More specifically, the design of fundamentally new materials depends on an understanding of how the desired structural theme or complex function is 'coded' into the molecular architecture of the reactants. The study of ASA is essential to all three disciplines. However, the design parameters, the control strategies, and the nature of the end products differ widely in these fields. The ASA interdisciplinary conference seeks to promote the exchange of ideas between different and weakly interacting communities, namely physics and chemistry of soft matter, supramolecular chemistry, and cell and molecular biology. Furthermore, it attempted to enhance contacts between industrial and academic research laboratories.
DTIC
Chemistry; Physics; Molecular Biology; Nanotechnology; Biomimetics

20030060502 NASA Marshall Space Flight Center, Huntsville, AL, USA
Mechanisms for the Crystallization of ZBLAN
Ethridge, Edwin C.; Tucker, Dennis S.; Kaukler, William; Antar, Basil; 2002 Microgravity Materials Science Conference; February 2003, pp. 211-219; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

The objective of this ground based study is to test the hypothesis that shear thinning (the non-Newtonian response of viscosity to shear rate) is a viable mechanism to explain the observation of enhanced glass formation in numerous low-g experiments. In 1-g, fluid motion results from buoyancy forces and surface tension driven convection. This fluid flow will introduce shear in undercooled liquids in 1-g. In low-g it is known that fluid flows are greatly reduced so that the shear rate in fluids can be extremely low. It is believed that some fluids may have weak structure in the absence of flow. Very small shear rates could cause this structure to collapse in response to shear resulting in a lowering of the viscosity of the fluid. The hypothesis of this research is that: Shear thinning in undercooled liquids decreases the viscosity, increasing the rate of nucleation and crystallization of glass forming melts. Shear in the melt can be reduced in low-g, thus enhancing undercooling and glass formation. The viscosity of a model glass (lithium di-silicate, L2S) often used for crystallization studies has been measured at very low shear rates using a dynamic mechanical thermal analyzer. Our results are consistent with increasing viscosity with a lowering of shear rates. The viscosity of L2S may vary as much as an order of magnitude depending on the shear rate in the temperature region of maximum nucleation and crystal growth. Classical equations for nucleation and crystal growth rates, are inversely related to the viscosity and viscosity to the third power respectively. An order of magnitude

variation in viscosity (with shear) at a given temperature would have dramatic effects on glass crystallization Crystallization studies with the heavy metal fluoride glass ZBLAN (ZrF2-BaF2-LaF3-AlF3-NaF) to examine the effect of shear on crystallization are being initiated. Samples are to be melted and quenched under quiescent conditions at different shear rates to determine the effect on crystallization. The results from this study are expected to advance the current scientific understanding of glass formation in low-g and glass crystallization under glass molding conditions and will improve the scientific understanding of technological processes such as fiber pulling, bulk amorphous alloys, and glass fabrication processes.
Author
Crystallization; Glass; Metal Fluorides; Crystal Growth; Shear Stress; Microgravity

20030060526 Tufts Univ., Medford, MA, USA
Optical Ellipsometry and X-ray Scattering for Characterizing Order in Liquid Crystalline Polymers and Biopolymers
Georgiev, Georgie; Cebe, Peggy; Valluzzi, Regina; Kaplan, David; 2002 Microgravity Materials Science Conference; February 2003, pp. 126; In English; See also 20030060494; No Copyright; A01, Hardcopy; Abstract Only; Available from CASI only as part of the entire parent document

We report results of optical and wide and small angle X-ray scattering studies of structure development in collagen-model peptides. Our custom built two-dimensional optical ellipsometer is used to provide retardance and azimuthal angle information about the state of order in optically anisotropic structures. Recently, we have applied this instrumentation to investigate biological molecules, viz., oligomeric peptides with amino acid structures that are models for collagen. Proline and hydroxyproline residues stabilize the triple-helical conformation of collagen proteins in the collagen consensus sequence. Regular modifications have been introduced into the collagen consensus sequence, forming model systems for the study of bio-macromolecular organization. The model systems are oligomers with hexapeptide sequences of the form: (Glu)5(Gly-Ala-Pro-Gly-Pro-Pro)6(Glu)5 or (Glu)5(Gly -Pro-Ala -Gly-Pro-Pro)6(Glu)5. The glutamic acid capping the ends of the hexapeptide sequences imparts solubility in water. Depending upon concentration and temperature, the peptides form lyotropic liquid crystalline structures, and maintain their order when dried to powders suitable for X-ray studies. Through the use of the high intensity source of X-radiation at the Brookhaven National Synchrotron Light Source, phase transformation kinetics and structure development are studied in-situ, providing time-resolved characterization of these peptides. Coupled with the optical imaging ellipsometry, these approaches provide the most complete information about microstructure in these systems. The goal of our research is to evaluate the ability of these model peptides for self-assembly into liquid crystalline and true three-dimensional crystalline phases and to assess the temperature stability of resultant higher order structures.
Author
Ellipsometry; Optical Properties; X Ray Scattering; Crystallinity; Biopolymers; Liquid Crystals; Imaging Techniques

20030060541 Colorado Univ., Boulder, CO, USA
Macrovoid Defect Growth during Evaporative Casting of Polymeric Membranes
Greenberg, A. R.; Khare, V. P.; Zartman, J.; Krantz, W. B.; Todd, P.; 2002 Microgravity Materials Science Conference; February 2003, pp. 268-279; In English; See also 20030060494; Original contains black and white illustrations
Contract(s)/Grant(s): NAG8-1475; No Copyright; Avail: CASI; A03, Hardcopy

Macrovoid (MV) formation is a significant problem in evaporatively cast polymeric membranes. MVs are large, elongated or teardrop-shaped pores (~10-50 micron) that can impair membrane structural integrity. Although MVs have been extensively studied, there is no general agreement on the mechanisms governing MV growth. Recently, our research group has formulated the solutocapillary convection (SC) hypothesis, which contends that MV growth involves three principal forces: a Marangoni force generated by surface tension gradients within the MV interface, a viscous drag force, and a gravitationally induced body force. Two sets of complementary experiments were conducted to test the SC hypothesis. Ground-based videomicroscopy flow-visualization (VMFV) was utilized to measure the flow velocities at the MV-casting solution interface and deep within the casting solution. The measurements were performed with casting solutions containing 10 wt% cellulose acetate (CA), 30 wt% H2O, 60 wt% acetone, and 200- ppm TiO2 particles for flow visualization, and the surface tension was controlled by surfactant addition. Qualitatively, the experiments indicated that MV growth occurs in three distinct phases: (1) a very rapid initial growth period, (2) a much slower growth phase, and (3) absorption of selected MVs into the expanding demixed region. The presence of tracer particles inside the MVs suggests the presence of a convective flow, which transfers the particles from the bulk solution to the MV interior. Although the VMFV experiments did not establish any surfactant effect on the interfacial velocities, a statistically significant effect on the MV number density was observed. In the second set of experiments, membranes were cast aboard a KC-135 aircraft under 0-g and 2-g conditions. Despite careful attention to the design and fabrication of the membrane casting apparatus (MCA), several problems were encountered, the most significant of which was

the contamination of the casting solution by the activated carbon particles used for solvent absorption.
Author
Microporosity; Voids; Porous Materials; Evaporation; Membranes; Polymeric Films

20030060549 Tufts Univ., Medford, MA, USA
Nanolayered Features of Collagen-like Peptides
Valluzzi, Regina; Bini, Elisabetta; Haas, Terry; Cebe, Peggy; Kaplan, David L.; 2002 Microgravity Materials Science Conference; February 2003, pp. 311-319; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

We have been investigating collagen-like model oligopeptides as molecular bases for complex ordered biomimetic materials. The collagen-like molecules incorporate aspects of native collagen sequence and secondary structure. Designed modifications to native primary and secondary structure have been incorporated to control the nanostructure and microstructure of the collagen-like materials produced. We find that the collagen-like molecules form a number of lyotropic rod liquid crystalline phases, which because of their strong temperature dependence in the liquid state can also be viewed as solvent intercalated thermotropic liquid crystals. The liquid crystalline phases formed by the molecules can be captured in the solid state by drying off solvent, resulting in solid nanopatterned (chemically and physically) thermally stable (to greater than 100 C) materials. Designed sequences which stabilize smectic phases have allowed a variety of nanoscale multilayered biopolymeric materials to be developed. Preliminary investigations suggest that chemical patterns running perpendicular to the smectic layer plane can be functionalized and used to localize a variety of organic, inorganic, and organometallic moieties in very simple multilayered nanocomposites. The phase behavior of collagen-like oligopeptide materials is described, emphasizing the correlation between mesophase, molecular orientation, and chemical patterning at the microscale and nanoscale. In many cases, the textures observed for smectic and hexatic phase collagens are remarkably similar to the complex (and not fully understood) helicoids observed in biological collagen-based tissues. Comparisons between biological morphologies and collagen model liquid crystalline (and solidified materials) textures may help us understand the molecular features which impart order and function to the extracellular matrix and to collagen-based mineralized tissues. Initial studies have utilized synthetic collagen-like peptides while future work will also focus on similar sequences generated via genetic engineering methods.
Author
Collagens; Peptides; Oligomers; Nanostructure (Characteristics); Microstructure; Biomimetics

20030060555 NASA Marshall Space Flight Center, Huntsville, AL, USA
CO2 Acquisition Membrane (CAM)
Mason, Larry W.; Way, J. Douglas; Vlasse, Marcus; 2002 Microgravity Materials Science Conference; February 2003, pp. 390; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

The objective of CAM is to develop, test, and analyze thin film membrane materials for separation and purification of carbon dioxide (CO2) from mixtures of gases, such as those found in the Martian atmosphere. The membranes are targeted toward In Situ Resource Utilization (ISRU) applications that will operate in extraterrestrial environments and support future unmanned and human space missions. A primary application is the Sabatier Electrolysis process that uses Mars atmosphere CO2 as raw material for producing water, oxygen, and methane for rocket fuel and habitat support. Other applications include use as an inlet filter to collect and concentrate Mars atmospheric argon and nitrogen gases for habitat pressurization, and to remove CO2 from breathing gases in Closed Environment Life Support Systems (CELSS). CAM membrane materials include crystalline faujasite (FAU) zeolite and rubbery polymers such as silicone rubber (PDMS) that have been shown in the literature and via molecular simulation to favor adsorption and permeation of CO2 over nitrogen and argon. Pure gas permeation tests using commercial PDMS membranes have shown that both CO2 permeance and the separation factor relative to other gases increase as the temperature decreases, and low (Delta)P(Sub CO2) favors higher separation factors. The ideal CO2/N2 separation factor increases from 7.5 to 17.5 as temperature decreases from 22 C to -30 C. For gas mixtures containing CO2, N2, and Ar, plasticization decreased the separation factors from 4.5 to 6 over the same temperature range. We currently synthesize and test our own Na(+) FAU zeolite membranes using standard formulations and secondary growth methods on porous alumina. Preliminary tests with a Na(+) FAU membrane at 22 C show a He/SF6 ideal separation factor of 62, exceeding the Knudsen diffusion selectivity by an order of magnitude. This shows that the membrane is relatively free from large defects and associated non-selective (viscous flow) transport mechanisms. The Membrane Test Facility (MTF) has been developed to measure membrane permeance over a wide range of temperature and pressure. The facility uses two volume compartments separated by the membrane that are instrumented to measure temperature, delta pressure across the membrane, and gas

composition. A thermal shroud supports and encloses the membrane, and provides temperature control. Methods were developed to determine membrane permeance using the first order decay of the pressure difference between the sealed compartments, using the total pressure for pure gases, and partial pressure of each species in gas mixtures. The technique provides an end-to-end measurement of gas permeance that includes concentration polarization effects. Experiments have shown that in addition to membrane permeance properties, the geometry and design of associated structures play an important role in how membrane systems will function on Mars.
Author
Carbon Dioxide; Membranes; Performance Tests; Thin Films; Gas Mixtures; In Situ Resource Utilization; Purification; Zeolites; Polymers

20030060592 Cornell Univ., NY, USA
Influence of Processing Conditions on the Low Temperature Properties of Glasses
Wrubel, J. P.; Agladze, N. I.; Sievers, A. J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 566-574; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Microgravity has been shown to offer a unique environment for producing silicate and chalcogenide glasses of exceptionally low crystallinity and high homogeneity. An Earth-based method that has been shown to produce glasses with quality approaching that in microgravity, suppresses heterogeneous nucleation by levitating the melt on a film of gas, and thereby eliminates contact with the container walls. This method is called gas film levitation (GFL). Microgravity and GFL glass processing techniques are important for the understanding of the properties of glasses for two reasons. First, glasses known as fragile have a much higher tendency to crystallize than their stronger counterparts. Varying levels of crystallinity, especially in the fragile glasses, may obscure the low temperature anomalies known to occur in glasses. Secondly, because of the non-equilibrium structure, the cooling rate may directly influence the low temperature properties. Since microgravity and GFL processing suppress bulk crystallization, these tools are key to resolving the influence of the high temperature properties of glasses on the low temperature ones. At the same time, by suppressing crystallization, a wider range of cooling rates is possible and a systematic analysis of the effect of cooling rate on the glassy properties can occur.
Derived from text
Levitation Melting; Silica Glass; Low Temperature; Crystallinity

20030060635 NASA Langley Research Center, Hampton, VA, USA
Tensile Properties of a Cellulose Ether Hydrogel
Hinkley, Jeffrey A.; Gehrke, Stevin H.; June 6, 2003; 16 pp.; In English
Contract(s)/Grant(s): WU 762-30-51-01
Report No.(s): NASA/TM-2003-212417; L-18295; NAS 1.15:212417; No Copyright; Avail: CASI; A03, Hardcopy

Poly(hydroxycellulose) solutions were molded into dumbell-shaped specimens crosslinked with divinyl sulfone. The resulting hydrogels were tested in tension at room temperature and also at a temperature above the 40 C shrinkage transition. In contrast to behavior seen in some other responsive gels, apparent initial tangent moduli were lower in the shrunken state; breaking elongations were significantly higher. Possible molecular mechanisms are suggested, and implications for the design of temperature-responsive actuators (‘artificial muscles’) from this material are discussed.
Author
Tensile Properties; Cellulose; Ethers; Gels

20030060671 Army Engineer Research and Development Center, Vicksburg, MS, USA
Technology Demonstration of Thermal Spray Vitrification Process at Fort Drum, NY. Cost and Performance Report
Kumar, Ashok; Zatorski, Ray; Weber, Robert; Stephenson, L. D.; Jan. 2003; 38 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412669; ERDC/CERL-TR-03-4; No Copyright; Avail: CASI; A03, Hardcopy

The thermal spray vitrification (TSV) process was developed and patented by ERDC/CERL to remove lead-based paint from steel structures. TSV consists of spraying a molten glass from a thermal spray torch onto a painted steel surface. When the glass strikes the paint, it pyrolyzes the organic components, and lead is trapped within the glass, which cracks and spalls off the substrate. Remelting the vitrified paint residue immobilizes the lead in the glassy iron silicate matrix, and renders the waste nonhazardous. This report documents the results of a demonstration of TSV on a fire hydrant at Fort Drum, NY, along with an innovative hand-held high-frequency paint removal device that was used in conjunction with the TSV process. TSV results in significant cost savings, as no containment structures or worker health and environmental monitoring are required.

The formation of a nonhazardous waste also decreases disposal costs. At this time, the TSV process is best suited to niche markets where the cost of full containment structures cannot be spread over a large area.
DTIC
Vitrification; Thermodynamic Properties; Sprayers; Cost Analysis; Technology Utilization

20030061110 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
The Preparation and Properties of Polymer/Nanoparticle Blends Using POSS
Blanski, Rusty L.; Phillips, Shawn H.; Lee, Andre; 11 Jun. 2001; 15 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410906; AFRL-PR-ED-VG-2001-134; No Copyright; Avail: CASI; A03, Hardcopy
No abstract available
DTIC
Polymers; Nanostructure (Characteristics)

20030061183 Army Research Lab., Aberdeen Proving Ground, MD
Emission and Mechanical Evaluations of Vinyl-Ester Resin Systems
Sands, James M.; Ulven, Chad A.; Vaidya, Uday K.; Mar. 2003; 30 pp.; In English
Contract(s)/Grant(s): Proj-PP1271
Report No.(s): AD-A412891; ARL-TR-2930; No Copyright; Avail: CASI; A03, Hardcopy
Vinyl-ester resins (VE) are frequently used in liquid molding of composite materials for several applications including naval and army structures, commercial boat manufacturing, and building construction. Currently, commercially available VE products contain large amounts of styrene monomer, which is released as a hazardous air pollutant (HAP) during mixing, processing, curing, and fielding of VE-based composite structures. As federal emission standards continue to regulate the release of volatile organic compounds (VOCs) and HAPs, alternative low-mission reactive diluents or low-styrene concentration VEs must be designed to meet emission limits without financial penalties. Currently, steps are being taken to develop low-cost, alternative composite resin systems comprised of lower styrene concentrations. These resin systems will prove an effective means to reduce or eliminate VOC release. In this study, commercial VE formulations are tested for both emission and mechanical properties to establish a baseline for comparing new VE performances. A method of evaluating the emission rate is developed using mass loss of VOC as a function of time and temperature. The impact of selected parameters on the observed rate of mass loss is evaluated using a preliminary model to compare resin systems. Finally, the material performance of commercial VEs is evaluated using thermal-mechanical evaluation methods to provide material targets for new formulations.
DTIC
Exhaust Emission; Esters; Resins; Organic Compounds; Vinyl Polymers; Mechanical Properties

20030061394 NASA Marshall Space Flight Center, Huntsville, AL, USA
Protein Crystal Growth With the Aid of Microfluidics
vanderWoerd, Mark; [2003]; 1 pp.; In English; Materials and Crystal Growth Seminar, 16 Dec. 2002, Huntsville, AL, USA; No Copyright; Avail: Other Sources; Abstract Only
Protein crystallography is one of three well-known methods to obtain the structure of proteins. A major rate limiting step in protein crystallography is protein crystal nucleation and growth, which is still largely a process conducted by trial-and-error methods. Many attempts have been made to improve protein crystal growth by performing growth in microgravity. Although the use of microgravity appears to improve crystal quality in some attempts, this method has been inefficient because several reasons: we lack a fundamental understanding of macromolecular crystal growth in general and of the influence of microgravity in particular, we have to start with crystal growth conditions in microgravity based on conditions on the ground and finally the hardware does not allow for experimental iteration without reloading samples on the ground. To partially accommodate the disadvantages of the current hardware, we have used microfluidic technology (Lab-on-a-Chip devices) to design the concept of a more efficient crystallization device, suitable for use on the International Space Station and in high-throughput applications on the ground. The concept and properties of microfluidics, the application design process, and the advances in protein crystal growth hardware will be discussed in this presentation. Some examples of proteins crystallized in the new hardware will be discussed, including the differences between conventional crystallization versus crystallization in microfluidics.
Author
Protein Crystal Growth; Proteins; Crystallography; Microstructure; Chips (Electronics); Product Development

20030061396 NASA Marshall Space Flight Center, Huntsville, AL, USA

Contamination, UV Radiation, and Atomic Oxygen Effects on ISS Thermal Control Materials

Finckenor, Miria; Visentine, Jim; Adam, Steven; Zwiener, Jim; Loebs, Valerie; [2003]; 2 pp.; In English; 41st AIAA Aerospace Sciences Meeting, 6-9 Jan. 2003, Reno, NV, USA

Contract(s)/Grant(s): 478-88-50; Copyright; Avail: Other Sources

Thermal control surfaces for the International Space Station (ISS) have been designed and tailored for optimum optical performance. The orbital space environment, particularly molecular contamination, ultraviolet (UV) radiation, and atomic oxygen (AO), will have a detrimental effect on these optical properties. These effects must be quantified for modeling and planning for orbital change-out of the degraded elements. Also of interest was the effect of porosity on the reactions to the simulated space environment. Five materials were Z-93 white coating, silverized Teflon, chromic acid anodized aluminum, sulfuric acid anodized aluminum, and 7075-T6 aluminum. Some of the samples were exposed to RTV 560 silicone; others were exposed to Tefzel offgassing products. Two samples of Z-93 not exposed to contamination were used as clean controls. Vacuum ultraviolet (VUV) lamps were used to simulate a radiation exposure of one year on orbit and to photo-fix the contaminant films to the material surfaces, then the samples were exposed to AO. All samples were exposed to 1000 equivalent sun-hours (ESH) of vacuum ultraviolet radiation (VUV) at the AZ Technology facility and a minimum of 1.5 x 10(exp 20) atoms/sc cm of AO at Marshall Space Flight Center. Half of the samples were exposed to 2000 ESH of VUV at Huntington Beach and measured ex-situ before being sent to AZ Technology for further exposure. Darkening of the Z-93 white coating was noted after both VUV exposures. AO exposure did bleach the Z-93 but not back to its original brightness. Solar absorptance curves show the degradation due to molecular contamination and VUV and the recovery with AO exposure. More bleaching was noted on the Tefzel-contaminated samples than with the RTV-contaminated samples.

Author

Contamination; Oxygen; Surface Temperature; Optical Properties; Far Ultraviolet Radiation

20030061398 NASA Marshall Space Flight Center, Huntsville, AL, USA

Synthesis and Characterization of Carbon Nanotubes for Reinforced and Functional Applications

Zhu, Shen; Su, C.-H.; Lehoczky, S.; Watson, M.; [2003]; 1 pp.; In English; Nano and Microsystems Technology and Metrology Conference, 4-5 Dec. 2002, Redstone Arsenal, AL, USA; Copyright; Avail: Other Sources; Abstract Only

Many efforts have been engaged recently in synthesizing single-walled and multi-walled carbon nanotubes due to their superior mechanical, electrical and thermal properties, which could be used for numerous applications to enhance the performance of electronics, sensors and composites. This presentation will demonstrate the synthesizing process of carbon nanotube by thermal chemical vapor deposition and the characterization results by using electron microscopy and optical spectroscopy. Carbon nanotubes could be synthesized on various substances. The conditions of fabricating single-walled or multi-walled carbon nanotubes depend strongly on temperature and hydrocarbon concentration but weakly on pressure. The sizes, orientations, and growth modes of carbon nanotubes will be illustrated. The advantages and limitations of several potential aerospace applications such as reinforced and functional composites, temperature sensing, and thermal control by using carbon nanotubes will be discussed.

Author

Carbon Nanotubes; Synthesis (Chemistry); Thermodynamic Properties; Temperature Control; Mechanical Properties; Nanostructure Growth

20030061405 NASA Marshall Space Flight Center, Huntsville, AL, USA

Obtaining NASA Approval for use of Non-Metallic Materials in Manned Space Flight

Davis, Samuel E.; Wise, Harry L.; [2003]; 12 pp.; In English; SAMPE 2003, May 2003, Long Beach, CA, USA; Copyright; Avail: Other Sources

Material manufacturers and suppliers are often surprised when a material commonly provided to industry is not approved for use on manned spacecraft. Often the reason is a lack of test data in environments that simulate those encountered in space applications, especially oxygen-enriched conditions, which significantly increase both the likelihood of material combustion and the propagation of a fire. This paper introduces the requirements for flight approval of non-metallic materials, focusing on material testing for human-rated space flight programs; it reviews the history of flight materials requirements and provides the rationale for such and introduces specific requirements related to testing and to good material engineering and design practices. After describing the procedure for submitting materials to be tested, the paper outlines options available if a material fails testing. In addition, this treatise introduces the National Aeronautics and Space Administration's (NASA's) Materials and Processes Technical Information System (MAPTIS), a database housing all test data produced in accordance with

NASA-STD-6001, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion.
Author
Technology Utilization; Spacecraft Construction Materials; Manned Spacecraft; Flammability; Mechanical Properties

20030061407 NASA Marshall Space Flight Center, Huntsville, AL, USA, Universities Space Research Association, Huntsville, AL, USA
Surface Relaxation in Protein Crystals
Boutet, S.; Robinson, I. K.; Hu, Z. W.; Thomas, B. R.; Chernov, A. A.; [2002]; 1 pp.; In English
Contract(s)/Grant(s): NCC8-66; Copyright; Avail: Other Sources; Abstract Only

Surface X-ray diffraction measurements were performed on (111) growth faces of crystals of the Cellular iron-storage protein horse spleen ferritin. Crystal Trunkation Rods (CTR) were measured. A fit of the measured profile of the CTR revealed a surface roughness of 48 +/- 4.5 A and a top layer spacing contraction of 3.9 +/- 1.5\%. In addition to the peak from the CTR, the rocking curves of the crystals displayed unexpected extra peaks. Multiple-scattering is demonstrated to account for them. Future applications of the method could allow the exploration of hydration effects on the growth of protein crystals.
Author
Protein Crystal Growth; Surface Roughness; Measurement; Crystal Growth

20030061430 Texas Univ., Arlington, TX, USA
Handbook of Conducting Polymers, Second Edition, Revised and Expanded. M-I Transition in Doped Conducting Polymers
Skotheim, Terje A.; Elsenbaumer, Ronald L.; Reynolds, John R.; Jan. 1995; 59 pp.; In English
Contract(s)/Grant(s): N00014-91-J-1235
Report No.(s): AD-A411441; No Copyright; Avail: CASI; A04, Hardcopy

The initial impetus for the plethora of work on conducting polymers was generated by the discovery in 1977 of the increase, by nearly 10 orders of magnitude, in the electrical conductivity (sigma) of polyacetylene when it was doped with iodine or other acceptors. The subsequent demonstration of the important role of nonlinear excitations, solitons, polarons, and bipolarons upon chemical doping or photoexcitation in the semiconducting regime provided a conceptual framework for understanding the electronic structure of these novel polymer semiconductors at low doping levels 4-13. Although there has been impressive progress toward the goal of improving conductivity and achieving truly metallic polymers 14-17, parallel progress toward understanding the transport in the 'metallic' state has been limited by the quality of the disordered polymer materials.
DTIC
Conducting Polymers; Handbooks; Doping (Materials); Polyacetylene

28
PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels. For nuclear fuels see *73 Nuclear Physics*. For related information see also *07 Aircraft Propulsion and Power; 20 Spacecraft Propulsion and Power*; and *44 Energy Production and Conversion*.

20030060403 Clark-Atlanta Univ., GA, USA
Liquid Fuels: Pyrolytic Degradation and Fire Spread Behavior as Influenced by Buoyancy
Ross, Howard D., Technical Monitor; Yeboah, Yaw D.; June 2003; 49 pp.; In English
Contract(s)/Grant(s): NCC3-707; No Copyright; Avail: CASI; A03, Hardcopy

This project was conducted by the Combustion and Emission Control Lab in the Engineering Department at Clark Atlanta University under NASA Grant No. NCC3-707. The work aimed at providing data to supplement the ongoing NASA research activities on flame spread across liquid pools by providing flow visualization and velocity measurements especially in the gas phase and gas-liquid interface. During this investigation, the detailed physics of flame spread across liquid pools was revealed using particle image velocimetry (PIV), 3-dimensional Laser Doppler velocimetry (LDV) and high-speed video imaging system (HSVS). Flow fields (front and side views) of both the liquid and gas phases were visually investigated for the three subflash regimes of flame spread behavior. Some interesting findings obtained from the front and side views on flame spread across butanol pools are presented. PIV results showed the size of the transient vortex in the liquid phase near the flame front

varied with the initial pool temperature. The transient vortex ahead of the flame front in the gas phase was, for the first time, clearly observed located just within 0-3 mm above the liquid surface and its size was dependent on the initial pool temperature. We calculated the flow velocity at 1 mm below the liquid surface near the flame front and inferred the generation mechanism of the vortex in the gas phase. Finally, after comparison of the flow velocity of the liquid surface and the flame spread rate, a reasonable explanation to the formation mechanism of the pulsating characteristic was proposed. This explanation is compatible with the previous numerical calculations and deductions.
Author
Liquid Fuels; Pyrolysis; Flame Propagation; Buoyancy; Liquid Surfaces; Flow Visualization; Velocity Measurement; Gas-Liquid Interactions; Vapor Phases

20030060426 Air Force Research Lab., Edwards AFB, CA, USA
First Principles Calculation of the Chemisorption Properties of Nitro-Containing Molecules on the Al(111) Surface (Multiscale Simulations of High Energy Density Materials Challenge Project)
Sorescu, Dan C.; Boatz, Jerry A.; Thompson, Donald L.; May 17, 2002; 9 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410776; AFRL-PR-ED-TP-2002-115; No Copyright; Avail: CASI; A02, Hardcopy

First-principles calculations based on spin-polarized density functional theory (DFT) and the generalized gradient approximation (GGA) have been used to study the adsorption of nitromethane (NM), 1,1-diamino-2, 2-dinitroethylene (FOX7) and 1,3,5,7-tetranitro-1,3,5, 7-tetraazacyclooctane (HMX) on Al(111) surface. The calculations employ aluminum slab geometries and 3D periodic boundary conditions. Three surface models have been considered in these studies.
DTIC
Chemisorption; Simulation; Nitromethane; Aluminum Compounds; Solid Rocket Propellants

20030060681 NASA Glenn Research Center, Cleveland, OH, USA
Decomposing Solid Micropropulsion Nozzle Performance Issues
Reed, Brian; May 2003; 19 pp.; In English; 41st Aerospace Sciences Meeting and Exhibit, 6-9 Jan. 2003, Reno, NV, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 22-755-70-00-02
Report No.(s): NASA/TM-2003-212225; E-13845; NAS 1.15:212225; AIAA Paper 2003-0672; No Copyright; Avail: CASI; A03, Hardcopy

Micropropulsion technology is essential to the success of miniaturized spacecraft and can provide ultra-precise propulsion for small spacecraft. NASA Glenn Research Center has envisioned a micropropulsion concept that utilizes decomposing solid propellants for a valveless, leak-free propulsion system. Among the technical challenges of this decomposing solid micropropulsion concept is optimization of miniature, rectangular nozzles. A number of flat micronozzles were tested with ambient-temperature nitrogen and helium gas in a vacuum facility. The thrusters were etched out of silicon and had throat widths on the order of 350 microns and throat depths on the order of 250 microns. While these were half-sections of thrusters (two would be bonded together before firing), testing provided the performance trend for nozzles of this scale and geometry. Area ratios from 1 to 25 were tested, with thrust measured using an inverted pendulum thrust stand for nitrogen flows and a torsional thrust stand for helium. In the nitrogen testing, peak nozzle performance was achieved around area ratio of 5. In the helium series, nozzle performance peaked for the smallest nozzle tested area ratio 1.5. For both gases, there was a secondary performance peak above area ratio 15. At low chamber pressures (< 1.6 atm), nitrogen provided higher nozzle performance than helium. The performance curve for helium was steeper, however, and it appeared that helium would provide better performance than nitrogen at higher chamber pressures.
Author
Spacecraft Propulsion; Solid Propellants; Miniaturization; Thrustors; Nozzle Design; Nozzle Geometry; Nozzle Efficiency

20030060692 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Status of Cryosolid Propellants Task
Fajardo, Mario E.; DeRose, Michelle E.; May 2001; 41 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410774; AFRL-PR-ED-VG-2001-115; No Copyright; Avail: CASI; A03, Hardcopy

Presentation viewgraphs for Cryosolid Propellants Workshop on Air Force research into propulsion systems using solid hydrogen.
DTIC
Hydrogen; Cryogenic Rocket Propellants; Para Hydrogen

20030060733 Air Force Research Lab., Edwards AFB, CA, USA
Hydrocarbon Fuels Optimization
Mills, Jeffrey D.; February 15, 2002; 40 pp.; In English
Report No.(s): AD-A410680; AFRL-PR-ED-TP-2002-030; No Copyright; Avail: CASI; A03, Hardcopy

Hydrocarbon fuel performance in rockets is systematically considered using standard equilibrium isentropic one-dimensional computer codes with a new web-based interface. For reference engine conditions the optimized specific impulse depends only upon the mass-normalized (specific) enthalpy content and the hydrogen-to-carbon ratio. In this context promising families of strained and unsaturated high-energy hydrocarbon fuels; with special emphasis upon those currently under development by in-house researchers; are insightfully compared and justified. A variety of simple; mission-tailored metrics approximating payload mass gains and the relative importance of fuel density are considered with special application to similar kerosene fuels. In this way it is possible to begin to simply; if approximately; quantify some of the performance trade-offs among the relevant liquid-fuel physical and chemical properties and to easily screen a great number of possible fuels as a foundation for calculations employing more sophisticated and realistic rocket models.
DTIC
Hydrocarbon Fuels; High Energy Fuels; Rocket Propellants; Liquid Fuels

20030061070 Air Force Research Lab., Edwards AFB, CA, USA
Heat Transfer and Deposition Behavior of Hydrocarbon Rocket Fuels
Bates, Ron; Edwards, Tim; Meyer, Michael L.; December 27, 2002; 14 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410860; AFRL-PR-ED-TP-2002-320; No Copyright; Avail: CASI; A03, Hardcopy

As the desire to increase the performance of hydrocarbon/liquid oxygen rocket engines naturally leads to increased combustion chamber pressures and higher energy hydrocarbon fuels, the combustion chamber and nozzle heat fluxes also increase. For engines regeneratively cooled with hydrocarbon fuel, this additional thermal stress must be effectively carried by the fuel without degradation of the cooling channel surfaces. A methodology for evaluation of the thermal performance (thermal stability and heat transfer characteristics) of hydrocarbon rocket fuels is suggested. As part of that methodology, an experimental research program to investigate the thermal performance of several new candidate hydrocarbon rocket fuels has been started. The experimental program utilizes a series of test rigs of increasing complexity and fidelity to successively screen identified fuels without the cost and complexity of a full engine system level test. Results of small-scale thermal decomposition experiments utilizing a System for Thermal Decomposition Studies (STDS) test rig provide an initial evaluation of the thermal stability performance of fuels from very small fuel samples. Measurements of - heat transfer coefficient and the effect of wall temperature, flow velocity, and wetted- material on deposit formation in heated test channels are obtained from larger rigs, such as the NASA/GRC Heated Tube Facility and the AFRL/PRS High Heat Flux Facility.
DTIC
Rocket Engines; Hydrocarbon Fuels; Heat Transfer; Rocket Propellants

20030061102 Air Force Research Lab. Edwards AFB CA, Edwards AFB, CA, USA
Propellant Losses Because of Particulate Emission in a Pulsed Plasma Thruster
Spanjers, Gregory G.; Lotspeich, Jason S.; McFall, Keith A.; Spores, Ronald A.; Aug. 1998; 8 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410892; AFRL-PR-ED-TP-2003-011; No Copyright; Avail: CASI; A02, Hardcopy

Propellant inefficiency material in particulate form is characterized in a laboratory pulsed plasma thruster (PPT) operating at 1 Hz with a 204 discharge energy (20 W). Exhaust deposits are collected and analyzed using a combination of a scanning electron microscope with energy dispersive x-ray analysis and microscopic imaging. Teflon(trademark) particulates are observed with characteristic dianietens ranging from over 100 micrometers down to less than 1 micrometer.
DTIC
Propellants; Losses; Particulates; Pulsed Plasma Thrusters

20030061136 Air Force Research Lab., Edwards AFB, CA, USA
Bond Dissociation Energies of Energetic Compounds: A Comparison of Theoretical Methods
Boatz, Jerry; Thompson, Donald; Sorescu, Dan; May 23, 2001; 36 pp.; In English
Contract(s)/Grant(s): Proj-2303
Report No.(s): AD-A410757; AFRL-PR-ED-AB-2001-103; No Copyright; Avail: CASI; A03, Hardcopy
No abstract available
DTIC
Chemical Bonds; Organic Compounds; Solid Rocket Propellants; Nitrogen Compounds

20030061292 Air Force Research Lab., Edwards AFB, CA, USA
Initial Results from a Cryogenic Coaxial Injector in an Acoustic Field
Chehroudi, B.; Davis, D.; Talley, D.; Jan. 9, 2002; 9 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A410882; AFRL-PR-ED-TP-2003-322; No Copyright; Avail: CASI; A02, Hardcopy
A coaxial injector was made to inject liquid nitrogen (LN2) with a coflow of gaseous nitrogen (GN2) in its annular region as part, of a program to better understand the nature of the interaction between acoustic waves and liquid fuel jets in cryogenic rocket engines. The LN2 was injected into a room temperature high-pressure chamber having optical access on its sides. A piezo-siren capable of generating sound waves with an SPL of up to 180 dB was employed under two chamber pressures of 2.14 and 4.86 MPa. The reduced pressures for these pressures are 0.63 (subcritical), and 1.43 (supercritical), respectively. The assembly consisting of the acoustic driver and the high-pressure chamber form a cavity that resonates at several frequencies, the strongest being at 2700 and 4800 Hz. Initial results for only one LN2 flow rate but at three co-flow rates and at 2700 Hz are reported here. The nature of the aforementioned interactions has been captured via a CCD camera high-speed imaging system. These evidences indicate that the warmer co-flow GN2 affects the thermodynamic condition of the LN2 jet near the inner wall surface, reducing the jet initial visual diameter, particularly at higher co-flow rates. Dramatic effects of the periodic transverse acoustic waves can be seen to impose a sinusoidal shape to the jet appearance. The wavelength of this wavy shaped structure is established by the acoustic-induced transverse deflection of the jet considering the fact that the jet exists in the velocity anti-node of the acoustic field.
DTIC
Coaxial Flow; Injectors; Coaxial Nozzles; Liquid Nitrogen; Cryogenic Rocket Propellants

29
SPACE PROCESSING

Includes space-based development of materials, compounds, and processes for research or commercial application. Also includes the development of materials and compounds in simulated reduced-gravity environments. For legal aspects of space commercialization see *84 Law, Political Science and Space Policy*.

20030060512 Carnegie-Mellon Univ., Pittsburgh, PA, USA
Lattice Boltzmann Computations of Binary Diffusion in Liquids under Stochastic Microgravity
Sekerka, Robert F.; Sofonea, Victor C.; 2002 Microgravity Materials Science Conference; February 2003, pp. 556-565; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy
We have conducted research to further develop the Lattice Boltzmann (LB) model in liquids as a computational tool to better understand convective diffusion in stochastic microgravity. We focus on the prototype problem of mathematical modeling of binary liquid alloy diffusion couples. Our ultimate objective is to estimate the accuracy of, or make corrections to, binary liquid diffusivities measured in microgravity. The same methodology should be useful to analyze other experiments in microgravity that involve convective diffusion.
Derived from text
Binary Alloys; Microgravity; Diffusion; Mathematical Models; Boltzmann Distribution; Stochastic Processes; Liquid Alloys

20030060515 Illinois Univ., Urbana, IL, USA
Models to Optimize the Benefits of Steady and Rotating Magnetic Fields For Crystal Growth in Microgravity
Walker, John S.; 2002 Microgravity Materials Science Conference; February 2003, pp. 671-676; In English; See also 20030060494; No Copyright; Avail: CASI; A02, Hardcopy
Both steady and rotating magnetic fields have been proposed for crystal-growth furnaces currently being designed for

future experiments on the International Space Station (ISS). A steady magnetic field with a strength of 0.1-0.2 T would be produced by a solenoid placed around the crystal-growth furnace. A steady magnetic field can stabilize and tailor the thermocapillary and solutocapillary convections in the floating-zone and detached Bridgman processes. It can also damp the buoyant convection driven by g-jitters and steady residual accelerations. A rotating magnetic field (RMF) would be produced by inductors which are placed with equal azimuthal spacing around the furnace and which are connected to the successive phases of a multiphase AC power source. An RMF is an essentially spatially uniform transverse magnetic field which has a strength of 1-10 mT and which rotates around the furnace s centerline at 50-400 Hz. The azimuthal melt motion produced by an RMF can stabilize thermocapillary and buoyant convections through the Taylor effect, and it can drive a controllable radial velocity near the crystal-melt interface, thus producing radial uniformity of dopants and species in crystals. During the last two years, we have developed models to optimize the benefits of steady and rotating magnetic fields for future crystal-growth experiments on the ISS.
Author
Magnetic Fields; Crystal Growth; Furnaces; Thermocapillary Migration; Fluid Flow; Mathematical Models; Phase Transformations; Microgravity

20030060520 Alabama Univ., Birmingham, AL, USA
Coupled Growth in Hypermonotectics
Andrews, J. Barry; McFadden, Geoffrey; 2002 Microgravity Materials Science Conference; February 2003, pp. 34-41; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy

The overall objective of this project is to obtain a fundamental understanding of the physics controlling solidification processes in immiscible alloy systems. The investigation involves both experimentation and the development of a model describing solidification in monotectic systems. The experimental segment was designed to first demonstrate that it is possible to obtain interface stability and steady state coupled growth in hypermonotectic alloys through microgravity processing. Microgravity results obtained to date have verified this possibility (1). Future flights will permit experimental determination of the limits of interface stability and the influence of alloy composition and growth rate on microstructure. The objectives of the modeling segment of the investigation include prediction of the limits of interface stability, modeling of convective flow due to residual acceleration, and the influence of surface tension driven flows at the solidification interface (2). The study of solidification processes in immiscible alloy systems is hindered by the inherent convective flow that occurs on Earth and by the possibility of sedimentation of the higher density immiscible liquid phase. It has been shown that processing using a high thermal gradient and a low growth rate can lead to a stable macroscopically planar growth front even in hypermonotectic alloys (1,3). Processing under these growth conditions can avoid constitutional supercooling and prevent the formation of the minor immiscible liquid phase in advance of the solidification front. However, the solute depleted boundary layer that forms in advance of the solidification front is almost always less dense than the liquid away from the solidification front. As a result, convective instability is expected. Ground based testing has indicated that convection is a major problem in these alloy systems and leads to gross compositional variations along the sample and difficulties maintaining interface stability (4). Sustained low gravity processing conditions are necessary in order to minimize these problems and obtain solidification conditions that approach steady state.
Author
Space Processing; Monotectic Alloys; Spaceborne Experiments; Crystal Growth; Interface Stability; Directional Solidification (Crystals)

20030060540 NASA Marshall Space Flight Center, Huntsville, AL, USA
Flight Planning for the International Space Station - Levitation Observation of Dendrite Evolution in Steel Ternary Alloy Rapid Solidification (LODESTARS)
Flemings, Merton C.; Matson, Douglas M.; Hyers, Robert W.; Rogers, Jan R.; 2002 Microgravity Materials Science Conference; February 2003, pp. 221-230; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy

During rapid solidification, a molten sample is cooled below its equilibrium solidification temperature to form a metastable liquid. Once nucleation is initiated, growth of the solid phase proceeds and can be seen as a sudden rise in temperature. The heat of fusion is rejected ahead of the growing dendrites into the undercooled liquid in a process known as recalescence. Fe-Cr-Ni alloys may form several equilibrium phases and the hypoeutectic alloys, with compositions near the commercially important 316 stainless steel alloy, are observed to solidify by way of a two-step process known as double recalescence. During double recalescence, the first temperature rise is associated with formation of the metastable ferritic solid phase with subsequent conversion to the stable austenitic phase during the second temperature rise. Selection of which phase

grows into the undercooled melt during primary solidification may be accomplished by choice of the appropriate nucleation trigger material or by control of the processing parameters during rapid solidification. Due to the highly reactive nature of the molten sample material and in order to avoid contamination of the undercooled melt, a containerless electromagnetic levitation (EML) processing technique is used. In ground-based EML, the same forces that support the weight of the sample against gravity also drive convection in the liquid sample. However, in microgravity, the force required to position the sample is greatly reduced, so convection may be controlled over a wide range of internal flows. Space Shuttle experiments have shown that the double recalescence behavior of Fe-Cr-Ni alloys changes between ground and space EML experiments. This program is aimed at understanding how melt convection influences phase selection and the evolution of rapid solidification microstructures.
Author
Flight Plans; International Space Station; Levitation; Rapid Quenching (Metallurgy); Solidification; Steels; Ternary Alloys; Dendritic Crystals

20030060545 NASA Marshall Space Flight Center, Huntsville, AL, USA
Toward Understanding Pore Formation and Mobility during Controlled Directional Solidification in a Microgravity Environment Investigation (PFMI)
Grugel, Richard N.; Anilkumar, A. V.; Luz, Paul; Jeter, Linda; Volz, Martin P.; Spivey, Reggie; Smith, G.; 2002 Microgravity Materials Science Conference; February 2003, pp. 280; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

The generation and inclusion of detrimental porosity, e.g., pipes and rattails can occur during controlled directional solidification processing. The origin of these defects is generally attributed to gas evolution and entrapment during solidification of the melt. On Earth, owing to buoyancy, an initiated bubble can rapidly rise through the liquid melt and pop at the surface; this is obviously not ensured in a low gravity or microgravity environment. Clearly, porosity generation and inclusion is detrimental to conducting any meaningful solidification-science studies in microgravity. Thus it is essential that model experiments be conducted in microgravity, to understand the details of the generation and mobility of porosity, so that methods can be found to eliminate it. In hindsight, this is particularly relevant given the results of the previous directional solidification experiments conducted in Space. The current International Space Station (ISS) Microgravity Science Glovebox (MSG) investigation addresses the central issue of porosity formation and mobility during controlled directional solidification processing in microgravity. The study will be done using a transparent metal-analogue material, succinonitrile (SCN) and succinonitrile-water 'alloys', so that direct observation and recording of pore generation and mobility can be made during the experiments. Succinonitrile is particularly well suited for the proposed investigation because it is transparent, it solidifies in a manner analogous to most metals, it has a convenient melting point, its material properties are well characterized and, it has been successfully used in previous microgravity experiments. The PFMI experiment will be launched on the UF-2, STS-111 flight. Highlighting the porosity development problem in metal alloys during microgravity processing, the poster will describe: (i) the intent of the proposed experiments, (ii) the theoretical rationale behind using SCN as the study material for porosity generation and migration and, (iii) the experimental protocol for the investigation of the effects of the processing parameters. Photographs of the flight experimental hardware, and the novel sample ampoule, will be exhibited. The experimental apparatus will be described in detail and a summary of the scientific objectives will be presented.
Author
Microgravity; Porosity; Solidification; Spaceborne Experiments; Mobility

20030060558 Wisconsin Univ., Madison, WI, USA
Analysis of Containerless Solidification Microstructures in Undercooled Melts and Composite Systems
Perepezko, J. H.; 2002 Microgravity Materials Science Conference; February 2003, pp. 435-440; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

The main research objective is the evaluation and analysis of the undercooling and resultant solidification microstructures in containerless processing, including drop tube processing and levitation melt processing of selected alloys and composites. The results are intended for use as an experience base for the design of space-based microgravity experiments. Containerless processing in ground-based drop tubes simulates microgravity conditions via solidification of liquid samples under free fall conditions. The containerless environment is also attained in levitation melt processing and removes a major source of impurities and heterogeneous nucleation sites, allowing for a large melt undercooling. This enhanced liquid undercooling exposes alternate solidification pathways, allowing for the formation of novel microstructures. Controlling the undercooling level provides some control of the operative solidification pathway and the resultant microstructure. The novel structures that may be produced in a ground-based containerless processing facility preview the wide range of possible materials processing

experiments that may be conducted in a space-based laboratory. The results of the ground based study will be used to identify critical experimental variables in microgravity processing and the analysis can be used to design and define the science and hardware requirements for extended duration space experiments.
Derived from text
Microstructure; Solidification; Supercooling; Composite Materials; Microgravity; Containerless Melts; Spaceborne Experiments

20030060575 NASA Marshall Space Flight Center, Huntsville, AL, USA
Particle Engulfment and Pushing By Solidifying Interfaces - Recent Theoretical and Experimental Developments
Stefanescu, D. M.; Catalina, A. V.; Juretzko, Frank R.; Sen, Subhayu; Curreri, P. A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 586-596; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAS8-00207; No Copyright; Avail: CASI; A02, Hardcopy

The objective of the work on Particle Engulfment and Pushing by Solidifying Interfaces (PEP) include: 1) to obtain fundamental understanding of the physics of particle pushing and engulfment, 2) to develop mathematical models to describe the phenomenon, and 3) to perform critical experiments in the microgravity environment of space to provide benchmark data for model validation. Successful completion of this project will yield vital information relevant to a diverse area of terrestrial applications. With PEP being a long term research effort, this report will focus on advances in the theoretical treatment of the solid/liquid interface interaction with an approaching particle, experimental validation of some aspects of the developed models, and the experimental design aspects of future experiments to be performed on board the International Space Station.
Author
Microgravity; Morphology; Mathematical Models; Directional Solidification (Crystals); Liquid-Solid Interfaces; Spaceborne Experiments; Solidification

20030060587 NASA Marshall Space Flight Center, Huntsville, AL, USA
Solidification Using a Baffle in Sealed Ampoules (SUBSA)
Marin, C.; Ostrogorsky, A. G.; Volz, M.; Luz, P.; Jeter, L.; Spivey, R.; Burton, H.; Smith, G.; Knowles, T. R.; Bonner, W. A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 434; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Solidification Using a Baffle in Sealed Ampoules (SUBSA) will be the first materials science experiment conducted in the Microgravity Science Glovebox (MSG) Facility at the International Space Station (ISS) Alpha. The launch is schedule for May 31, 2002. Using the specially developed furnace, 10 Te and Zn-doped single crystals of InSb will be directionally solidified in microgravity. A key goal of the SUBSA investigation is to (i) clarify the origin of the melt motion in space laboratories and (ii) to reduce the magnitude of the melt motion to the point that it does not interfere with the transport phenomena. These goals will be accomplished through a special ampoule and furnace design. A disk-shaped baffle, positioned close to the freezing front, is used to reduce melt motion. Furthermore, the solidification will be visualized by using a transparent furnace, with a video camera, continuously sending images to the earth. This allows detection of bubbles and melt de-wetting that could cause surface tension driven convection. In preparation for the space experiments, 30 ground-based experiments were conducted. The results of ground based tests and numerical modeling will be presented. Based on numerical modeling, 12 mm 1D silica ampoules were selected. The small diameter ampoule favors closer placement of the baffle to the interface, without excessive radial segregation caused by forced convection while providing more damping of natural convection. The parts in the silica ampoule include 2 carbon springs made by Energy Science Laboratories, Inc., a pyrocarbon-coated graphite cylinder, pyrocarbon-coated graphite a baffle with the shaft and the InSb charge with the seed crystal grown by W.A. Bonner of Crystallod Inc.
Derived from text
Ampoules; Solidification; Spaceborne Experiments; Space Laboratories; Microgravity

20030061361 NASA Marshall Space Flight Center, Huntsville, AL, USA
Solidification Using the Baffle in Sealed Ampoules
Ostrogorsky, A.; Marin, C.; Churilov, A.; Volz, M. P.; Bonner, W. A.; Spivey, R. A.; Smith, G.; [2003]; 1 pp.; In English; 41st AIAA Aerospace Sciences Meeting, 6-9 Jan. 2003, Reno, NV, USA; Copyright; Avail: Other Sources; Abstract Only

Solidification Using a Baffle in Sealed Ampoules (SUBSA) is the first investigation conducted in the Microgravity Science Glovebox (MSG) Facility at the International Space Station (ISS) Alpha. In July, August and September of 2002, 8

single crystals of InSb, doped with Te and Zn, were directionally solidified in microgravity. Ground based tests, related numerical modeling and images of the growth process obtained in microgravity are presented.
Author
Directional Solidification (Crystals); Microgravity; Doped Crystals; Single Crystals; Spaceborne Experiments

31
ENGINEERING (GENERAL)

Includes general research topics related to engineering and applied physics, and particular areas of vacuum technology, industrial engineering, cryogenics, and fire prevention. For specific topics in engineering see *categories 32 through 39*.

20030059501 Tokyo Medical and Dental Univ., Japan
Estimation of Ambient Radiation Temperature for Emissivity-Corrected Thermography
Otsuka, K.; Okada, S.; Togawa, T.; Oct. 25, 2001; 4 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412089; No Copyright; Avail: CASI; A01, Hardcopy

A non-contact method for the measurement of emissivity, and emissivity-corrected temperatures has been developed, where the ambient radiation-temperature is changed in a discontinuous way. When the ambient radiation-temperature is unchanged quickly, so that the surface temperature of the object can be assumed to be unchanged, the radiometer output before, and immediately after that change can be expressed as two simultaneous equations. The temperature and emissivity of the surface can be derived by solving these equations when the ambient radiation- temperatures are known. In previous studies, one or two hoods were used to provide the ambient radiation-temperature. However, there was a problem in controlling the ambient radiation-temperature. A new method is introduced where two reference plates coated with paints of different emissivities are placed in the field of view of the infrared camera. Eight simultaneous equations were derived from regions of the plates, and the ambient radiation- temperatures before and after the change were obtained by solving these equations. The validity of fills method was confirmed by experiment. This method will eliminate the need to use hoods as in the previous report, and will simplify the equipment needed.
DTIC
Radiometers; Thermography; Emissivity; Simultaneous Equations; Background Radiation; Cameras

20030060661 Simulated Technologies, Inc., Mesa, AZ, USA
Training for Dynamic Aerospace Control: An Experiment in International Distributed Mission Training
Greschke, David A.; Bell, Herbert H.; Feb. 2003; 19 pp.; In English
Contract(s)/Grant(s): F41624-97-D-5000; Proj-2313
Report No.(s): AD-A412596; AFRL-HE-AZ-TP-2003-0001; No Copyright; Avail: CASI; A03, Hardcopy

High-fidelity virtual simulators and constructive simulations located in the District of Columbia Mesa, AZ; and Crawley, England were linked over commercial communications lines (Internet and Integrated Services Digital Network) using Distributed Interactive Simulation protocols. This distributed simulation network supported relatively complex mission scenarios that were flown repeatedly over a period of three days. This experiment demonstrated the capability of existing technology to support international Distributed Mission Training (DMT), enabled the engineering community to document the performance that technology, and identified specific technological limitations. It also enabled the operational and training communities to evaluate the potential utility of DMT for coalition training. The data collected and the lessons learned in this demonstration will help enhance the technical performance of DMT and reduce the time and expense required to develop an international DMT capability.
DTIC
Aerospace Systems; Distributed Interactive Simulation; Education; Communication Networks; Dynamic Control; International Relations

32
COMMUNICATIONS AND RADAR

Includes radar; radio, wire, and optical communications; land and global communications; communications theory. For related information see also 04 Aircraft Communications and Navigation; and *17 Space Communications, Spacecraft Communications, Command and Tracking*; for search and rescue, see *03 Air Transportation and Safety*; and *16 Space Transportation and Safety*.

20030060655 Katholieke Univ. te Leuven, Belgium
Decimative Subspace-Based Parameter Estimation Techniques Applied to Magnetic Resonance Spectroscopy Signals
Morren, G.; Lemmerling, P.; Huffel, S. V.; 25 Oct. 2001; 5 pp.; In English
Report No.(s): AD-A412464; No Copyright; Avail: CASI; A01, Hardcopy

In this paper, the problem of estimating the frequencies, dampings, amplitudes and phases of closely spaced complex damped exponentials in the presence of noise is considered. In several papers, declination is proposed as a way to increase the performance of subspace- based parameter estimation methods, in the case of over- sampling 123. In this paper, a novel extension of the HTLS-method 4 that operates directly on the decimated data matrix is presented, and it is compared to other decimation methods. Experiments on simulated nuclear magnetic resonance (NMR) spectroscopy signals show the influence of decimation on the accuracy and computational complexity of the estimators.
DTIC
Nuclear Magnetic Resonance; Computation; Spectroscopy; Magnetic Signals

20030061278 Department of Defense, Arlington, VA, USA
Information Technology Management: Transition From the Automatic Digital Network to the Defense Message System
8 Apr. 2003; 32 pp.; In English
Report No.(s): AD-A412661; OAIG-AUD-D-2003-075; No Copyright; Avail: CASI; A03, Hardcopy

Our overall audit objective was to determine whether DMS can replace critical AUTODIN messaging capabilities. Specifically, the audit reviewed and evaluated the development, fielding, and cost of DMS. We did not evaluate management controls because the audit was limited to a review of whether DMS as fielded could meet the requirements of users. See Appendix A for a discussion of the scope and methodology and for prior coverage related to the overall objective.
DTIC
Message Processing; Digital Systems; Telecommunication

20030061360 Bolt, Beranek, and Newman, Inc., Cambridge, MA, USA
Rough 'N' Ready: A Meeting Recorder and Browser
Makhoul, John; Kubala, Francis; Sep. 2002; 19 pp.; In English
Contract(s)/Grant(s): F30602-97-C-0253; Proj-F301
Report No.(s): AD-A411157; AFRL-IF-RS-TR-2002-237; No Copyright; Avail: CASI; A03, Hardcopy

The objective of this effort is to integrate and enhance existing technologies in speech recognition, speaker identification, and topic classification to provide cost-effective transcription, structural summarization, and retrieval of user-specified aspects of meetings. A software system consisting of a meeting recorder and browser was designed and developed to provide a higher level view of collaborative meetings, co-locational or distributed and a way to browse through and listen to those parts which are most relevant to the user.
DTIC
Speech Recognition; Computer Programs

20030061382 Universidad Politecnica de Valencia, Valencia, Spain
Design of a Prototype for Dynamic Electrocardiography Monitoring Using GSM Technology: GSM-Holter
Guillen, J. M.; Millet, J.; Cebrian, A.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411447; No Copyright; Avail: CASI; A01, Hardcopy

Monitoring patients with serious cardiovascular problems is invaluable in preventing further crises and achieving a faster, more effective attention. To this end, noninvasive cardiologic tests such as dynamic electrocardiography (e. g., Holter) have proven useful in clinical practice. The present document puts forward a novel Holter system that benefits from the GSM mobile telephony standard widespread technology. The suggested design adds to the traditional Holter capabilities the attractive features of real-time processing and possibility of monitoring the patients' heart anywhere, anytime.
DTIC
Electrocardiography; Telemetry

33
ELECTRONICS AND ELECTRICAL ENGINEERING

Includes development, performance, and maintainability of electrical/electronic devices and components; related test equipment; and microelectronics and integrated circuitry. for related information see also *60 Computer Operations and Hardware*; and *76 Solid-State Physics*. For communications equipment and devices see *32 Communications and Radar*.

20030059524 National Defence Research Establishment, Linkoeping, Sweden
Study of a Nematic Zero-Twist Liquid Crystal Spatial Light Modulator
Haellstig, E.; Lindgren, M.; Sjoeqvist, L.; Dec. 2001; 46 pp.; In English
Report No.(s): PB2003-104343; FOI-R-0345-SE; No Copyright; Avail: CASI; A03, Hardcopy

This report describes a characterization of a commercial liquid crystal light modulator (SLM). Several methods for determining optical properties of SLMs are discussed and evaluated. The methods have been tested both by simulations and by experimental studies. The phase response of an SLM is the relation between the applied voltage and phase modulation. Due to the nature of liquid crystals this relation is non-linear. By using look-up table (LUT), the relation can be adjusted to give a more linear response. Look-up tables, which almost produce a linear phase response, have been constructed by studying the phase response of the SLM. The effects of a non-linear response on laser beam steering and shaping were studied. For beam steering and shaping the optimized LUT improved the performance. The steering efficiency was increased with respect to the intensity in the first order diffraction peak. For beam shaping more of the power in the intended region and less outside was observed.
NTIS
Light Modulators; Liquid Crystals; Optical Properties; Computerized Simulation

20030060458 Naval Research Lab., Washington, DC
Fire Detection by Surface Acoustic Wave Chemical Sensor Systems
McGill, R. A.; Anderson, Mark R.; Venezky, David L.; Dec. 10, 1993; 75 pp.; In English
Report No.(s): AD-A412628; NRL/MR/6170--93-7421; No Copyright; Avail: CASI; A04, Hardcopy

Surface Acoustic Wave (SAW) Chemical Sensor systems have been developed to detect and identify fire threats for shipboard materials. The SAW sensor system is an electronic device that employs an array of SAW devices as a 'nose' for chemical vapor detection. Each SAW device in an array is coated with a different polymeric material that selectively absorbs different chemical vapors. Chemical vapors released by thermal decomposition of fire fields (e.g. insulation on electrical cable and thermal insulation foam) provide fingerprint patterns from the sensor array that allow identification of the source material associated with a flaming fire, smoldering fire or the threat of a fire (prior to release of smoke). A neural network routine that was trained with over 500 patterns from fire vapor tests correctly identified the source material for all fire threats tested and distinguished them from possible interference (e.g. AFFF and hydraulic fluid). The SAW sensor system has the potential to give an early warning prior to a flaming fire and, unlike a conventional fire detector in heavy smoke, identify the primary source material in the fire. This information will greatly assist in determining appropriate steps to take in preventing a flaming fire developing from smoldering material, and in taking the proper action in fighting flaming fires. In addition, the SAW sensor system can be used as a multitasking detector searching simultaneously for vapors associated with fires or potential fires, and hazardous chemical vapors from spills, leaks or chemical agent attack. Sensor responses are reversible, so an area exposed to toxic fumes can be monitored in real times as a decontaminating procedure progresses to a safe condition for personnel to enter the area.
DTIC
Detection; Fires; Sound Waves

20030060528 Massachusetts Inst. of Tech., MA, USA
Forces during Manufacture and Assembly of Micro-scale Discrete Electronic Components
Kershner, Ryan J.; Tupper, Malinda M.; Chopinaud, Marjorie; Ogawa, Takamichi; Cima, Michael J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 128-138; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A03, Hardcopy

Micron scale manufacturing is becoming increasingly important as the use of portable electronic devices grows. Integration of discrete, micron scale components into portable electronic devices, increased use of microelectromechanical systems, and scaling down of combinatorial approaches for materials development are driving a need for novel microscale assembly methods and a better fundamental understanding of forces on microscale objects. Our objective in this research was to explore the forces on micron scale objects during assembly processes. Our approach was to use controlled electric fields

to manipulate micron scale objects. An apparatus for manipulating micron-scale dry dielectric materials has been developed and used to collect and deposit polystyrene and silica spheres. A surface charge measurement device and finite element calculations have been used to quantify electrostatic forces on these particles. This technique not only provides insight into the forces on micron scale objects, but has direct application as a revolutionary rapid dry powder dispensing technique, which will increase the palette of materials available for exploration by high throughput combinatorial methods. A similar electric field technique has been used to manipulate micron scale silica particles in an aqueous medium. Metal microelectrodes were prepared by lithographic patterning. Particle motion was imaged in real time using an inverted metallurgical microscope focused on the plane containing the particles. Particles were observed to pack at the electrodes in the presence of an applied DC field. This particle motion was characterized as a function of field strength, pH, and ionic strength of the background electrolyte. AC fields were also employed in an attempt to reduce the polarization of the particles and electrodes. A particle chaining process is reported during which particles aggregate in single lines parallel to the applied AC field. Particles were also seen to adhere to the sapphire substrate near the electrodes during application of the field. A technique for tracking the two dimensional stochastic motion of particles settled on the substrate was developed and used to characterize the adhesion as a function of pH and ionic strength. Electrokinetic measurements for the particles and substrate were used as inputs to a dissimilar surface charge interaction model. The potential energy was calculated and used to explain the observed adhesion. The use of an applied electric field to attract powder particles from a powder bed to a charged electrode above the powder bed surface may be used to study forces on micron scale forces in an electric field, and has been applied to the development of a novel dry powder dispensing system. The electrostatic dispensing apparatus is shown. A surface charge measurement device was developed to measure any triboelectric surface charge that may have been deposited inadvertently on the surface of the powder bed in an effort to quantify Coulombic forces. This apparatus is also shown.
Derived from text
Manufacturing; Electrostatics; Electrohydrodynamics; Mathematical Models; Dielectrics

20030060676 University of Central Florida, Orlando, FL
Development of a Compact, Low Jitter Modelocked Semiconductor Diode Laser
Mar. 2003; 35 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F30602-99-1-0546; Proj-4600
Report No.(s): AD-A412676; AFRL-SN-RS-TR-2003-49; AFRL-SN-RS-TR-2003-49; No Copyright; Avail: CASI; A03, Hardcopy

This research project was aimed at generating a train of ultralow noise optical pulses from a semiconductor diode laser for applications in optical sampling. Typical optical sampling applications may be similar to that encountered in analog to digital converter scenarios. The performance parameters aimed for in this project would support 12 bits of effective resolution at a sampling rate of 10 gigasamples per second. The results of this effort show that by properly engineering the mode locked oscillator design, the timing stability of mode locked diode lasers may perform on a pair of atomic clocks.
DTIC
Semiconductor Diodes; Semiconductor Lasers; Optical Properties; Vibration; Fabrication; Laser Mode Locking

20030061087 California Univ., Berkeley, CA
Low Frequency Noise Characterization System of Advanced Electronics Devices
Weber, Eicke; Specht, Petra; Dec. 16, 2002; 32 pp.; In English
Contract(s)/Grant(s): F49620-01-1-0285
Report No.(s): AD-A410813; AFRL-SR-AR-TR-03-0019; No Copyright; Avail: CASI; A03, Hardcopy

To date, a rising need for high-speed low-noise electronic devices is observed for a wide variety of applications, including wireless or fiber communications. Low frequency noise poses a lower limit on the signal level in broadband circuits. Noise sources are related to various kinds of materials imperfections such as point or line defects, but also to interface interface defects or defects at contacts. As device dimensions decrease, the noise introduced by trapping-detrapping of carriers at deep defects becomes increasingly important. Therefore, the analysis of low frequency electrical noise can be a useful tool not only for the qualification of device performance, but also for the characterization of noise-generating deep level defects in semiconductor materials. The advantages of this technique include the possibility of measuring fully processed device structures and the direct relevance of the measured defect characteristics to device performance Reduction of the noise level frequently requires the correct identification of noise sources. However, difficulties can arise in the interpretation of often-indistinct noise spectrum features.
DTIC
Electronic Equipment; Low Noise

20030061103 Air Force Research Lab., Edwards AFB, CA, USA

Interactions Within a Cluster of Low Power Hall Thrusters

Hargus, W. J., Jr; Jan. 8, 2003; 9 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): Proj-1011

Report No.(s): AD-A410886; AFRL-PR-ED-TP-2003-010; No Copyright; Avail: CASI; A02, Hardcopy

We discuss appearance of an anode current transient which persists a maximum of 500 seconds and results in a 50\% increase in the anode current during initial start-up following exposure to ambient laboratory conditions. The anode current transient is characterized by 18 kHz main discharge on/off behavior. This contrasts with the steady state behavior of a strong DC component overlaid with a low amplitude 25 kHz component. Conduction through the radial magnetic field appears to be modified during the transient period. The main discharge chamber is determined to be the source of this behavior. The anode current transient appears to be a result of water absorption on the surface layer of the boron nitride insulator. We speculate as to the connection between the absorption of water and the anode current transient. The modification of the secondary electron emission coefficient could affect near wall conductivity and produce the measured effects. The introduction of hydrogen from dissociated water could also produce these enhanced oscillations.

DTIC

Anodes; Hall Thrusters; Direct Current; Secondary Emission

20030061134 Memphis Univ., Memphis, TN, USA, NASA Marshall Space Flight Center, Huntsville, AL, USA

RF Frequency Oscillations in the Early Stages of Vacuum Arc Collapse

Griffin, Steven T.; Thio, Y. C. Francis; [2003]; 4 pp.; In English; 15th Topical Conference on Radio Frequency Power in Plasmas, 19-21 May 2003, Moran, WY, USA; No Copyright; Avail: CASI; A01, Hardcopy

RF frequency oscillations may be produced in a typical capacitive charging / discharging pulsed power system. These oscillations may be benign, parasitic, destructive or crucial to energy deposition. In some applications, proper damping of oscillations may be critical to proper plasma formation. Because the energy deposited into the plasma is a function of plasma and circuit conditions, the entire plasma / circuit system needs to be considered as a unit To accomplish this, the initiation of plasma is modeled as a time-varying, non-linear element in a circuit analysis model. The predicted spectra are compared to empirical power density spectra including those obtained from vacuum arcs.

Author

Network Analysis; Plasma Guns; Plasma Oscillations; Radio Frequencies; Pulse Generators; Power Spectra; Capacitance; Electric Networks

20030061281 Polish Academy of Sciences, Warsaw, Poland

Thin Solid Films: An International Journal on the Science and Technology of Condensed Matter Films, Volume 412, Nos. 1-2

Greene, J.E.; Desjardins, P.; Kossut, J.; Jun. 3, 2002; 149 pp.; In English

Contract(s)/Grant(s): N68171-01-M-6331

Report No.(s): AD-A412911; R/D-9227-PH-03; No Copyright; Avail: CASI; A07, Hardcopy

Contents: Preface (J. Kossut); Hybrid epitaxial structures for spintronics (J. De Boeck, W. Van Roy, et al.); Size effects in epitaxial films of magnetite (J. Korecki, B. Handke, et al.); Shadow mask technology (T. Schallenberg, C. Schumacher, et al.); Trions as a probe of spin injection through II-VI magnetic/ non-magnetic heterointerface (M. Ghali, J. Kossut. et al.); The growth modes of epitaxial Au/Co/Au sandwiches (A. Wawro, L.T. Baczewski, et al.); Polarity selection process and polarity manipulation of GaN in MOVPE and RF-MBE growth (A. Yoshikawa, K. Xu); SiGe(C) epitaxial technologies--Issues and prospectives (T.J. Grasby, T.E. Whall, et al.); Influence of covering on critical thickness of strained In(x) Ga(1-x)As layer (A. Jasik, K. Kosiel, et al.); MOVPE technology and characterisation of silicon &-doped GaAs and Al(x)Ga(1-x)As (B. Ciana, D. Radziewicz, et al.); Explanation of the initial phase change vs. incident angle of the RHEED intensity oscillation (A. Nemcsics); Laterally overgrown structures as substrates for lattice mismatched epitaxy (Z.R. Zytkiewicz); Monitoring epiready semiconductor wafers (D.A. Allwood, S. Cox, et al.); Post-growth thermal treatment of self-assembled InAs/GaAs quantum dots (A. Babinski, J. Jasinski); CdSe quantum islands in ZnSe: A new approach (E. Kurtz, B. Dal Don, et al.); CdTe/ZnTe quantum dots--Growth and optical properties (S. Mackowski); Investigations of optical properties of active regions in vertical cavity surface emitting lasers grown by MBE (K. Regiski, T. Ochalski, et al.); Photoluminescence mapping and angle-resolved photoluminescence of MBE-grown InGaAs/GaAs RC LED and VCSEL structures (A. Wojcik, T.J. Ochalski, et al.); Ferromagnetic GaMnAs/GaAs superlattices--MBE growth and magnetic properties (J. Sadowski, R. Mathieu, et al.);

and MBE growth and characterization of Hg based compounds and heterostructures (C.R. Becker, X.C. Zhang, et al.)
DTIC
Gallium Arsenides; Thin Films; Semiconducting Films; Vapor Deposition; Crystal Growth

20030061343 Naval Undersea Warfare Center, Newport, RI
Microstrip Patch Antenna with Progressive Slot Loading
Tonn, David A., Inventor; January 27, 2003; 11 pp.; In English
Patent Info.: Filed 8 Oct. 2002; US-Patent-Appl-SN-10267593
Report No.(s): AD-D020058; No Copyright; Avail: Other Sources

A microstrip patch antenna with progressive slot loading is provided. A rectangular patch of electrically conductive material has a plurality of slots formed therein with each slot having its center aligned with the centerline of the patch's long dimension. Each slot further has its longitudinal axis perpendicular to the centerline. The slots are arranged in an order starting at a position n=1 that is furthest from the patch's feedpoint so that, for an n-th slot, the inequalities Ln>Ln+i and W(n)<W(n+1) are always satisfied. In general the length decreases linearly with each successive slot while the width increases exponentially with each successive slot.
DTIC
Microstrip Antennas; Patch Antennas; Slots; Loads (Forces)

20030061357 Illinois Univ.
Antenna Array Methods for Communications, Direction Estimation, and GPS
Nehorai, Arya; Feb. 25, 2003; 18 pp.; In English
Contract(s)/Grant(s): F49620-00-1-0083
Report No.(s): AD-A411159; No Copyright; Avail: CASI; A03, Hardcopy

We developed a unified statistical framework for deriving signal processing methods. In electromagentics we developed methods for source tracking using an EM vector- sensor antenna; we designed such an antenna of compact shape. In radar we derived Cram/'er-Rao bounds for estimating a target range, velocity, and direction; developed a novel parametric approach for estimating and mitigating interferences in STAP. In communications we considered space-time fading channel estimation and symbol detection in spatially correlated noise; finite-length MIMO adaptive equalization; and channel estimation for OFDM wireless systems. In acoustics we considered wideband source localization using a distributed acoustic vector-sensor array; source direction with an array near a boundary; and noise-reduction algorithm for dual-microphone systems. We analyzed the cross-correlations between wide-band noise components of a vector sensor. We applied our results to various biomedical problems. Several successful transitions resulted from this project.
DTIC
Signal Processing; Antenna Arrays

20030061367 California Univ., Berkeley, CA, USA
Integrated mFlume Reconstitution System for Biological and Medical Supplies. Integrated MEMS Delivery System for Both Liquid and Reconstituted Drugs
Liepmann, Dorian; November 2001; 7 pp.; In English
Contract(s)/Grant(s): F33615-97-1-2730; Proj-ARPP
Report No.(s): AD-A411286; FUND25313-23795; AFRL-PR-WP-TM-2003-2013; No Copyright; Avail: CASI; A02, Hardcopy

The overall goal of this project was to develop an integrated mFLUME system for the reconstitution, metering, and delivery of biological and medical supplies. This system would allow for the on-demand reconstitution of a wide range of medical supplies that have been stored in dry form for robustness, convenience, and shelf life. The MEMS system required the development and integration of micro-fluidic control components, including valves, pumps, mixing chambers, and fluid ejection ports, with dry material and solvent reservoirs and on-board electronic control systems. A fully integrated device for the reconstitution of a lyophilized drug was never created. However, under this contract, significant advances were made in the area of MEMS-based fluid control systems, including planar valves, mixers, pumps, and interconnects. In addition, integration of a working microFLUMES device into an injection-molded package was demonstrated under a contract extension. In addition, attention was brought to the MEMS community regarding micro-fluid mechanical processes, including the presence and effects of large momentum and scalar gradients.
DTIC
Drugs; Medical Equipment; Injection Molding; Microelectromechanical Systems

20030061368 Missouri Univ., Rolla, MO, USA
Metal Deposition from Organic Solutions for Microelectronic Applications
Dahlgren, E.; Sun, J.; Fang, R.; OKeefe, T. J.; OKeefe, M. J.; Oct. 2001; 9 pp.; In English
Contract(s)/Grant(s): F33615-00-2-1718; Proj-ARPS
Report No.(s): AD-A411343; AFRL-SN-WP-TP-2002-109; No Copyright; Avail: CASI; A02, Hardcopy

A unique method for electrochemically depositing metal films from organic solutions was previously demonstrated. It was shown that by plating with this method, metallic particles and layers could be deposited on metals commonly used in the microelectronics industry. The deposition mechanism involved the dissolution of a less noble substrate metal and the simultaneous deposition of more noble metal particles on the surface of substrate, similar to immersion plating in aqueous solutions. This process was also shown to be capable of producing selectively deposited seed layers only on exposed reactive metal surfaces for subsequent electroless and electrolytic metal depositions. This process was highly selective and was compatible with film depositions onto patterned and unpatterned substrates, including printed circuit boards and silicon wafers. Refinement and optimization of the process have resulted in extending the technology to include the deposition of Cu and Pd seed layers from organic solutions onto TiSiN barrier films using in situ activating agents. Additionally, the process was modified to selectively deposit continuous Au films on Cu laminated FR-4 substrates and sputter-deposited Cu films. In this study, the ability to selectively deposit adherent Au thin films and Cu or Pd seed layers from an organic solution onto patterned and unpatterned substrates is demonstrated. The results from process development and microstructural characterization of the deposits are presented.
DTIC
Microelectronics; Metal Films; Noble Metals; Microstructure; Aqueous Solutions

20030061415 Universidad Politecnica de Valencia, Valencia, Spain
Identification of the Slow Wave of Small Bowel Myoelectrical Activity by Surface Recording
Martinez-DeJuan, J. L.; Saiz, F. J.; Silvestre, J.; Ponce, J. L.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): GV99-170-1-12
Report No.(s): AD-A411331; No Copyright; Avail: CASI; A01, Hardcopy

The bioelectrical signal (electroenterogram) is recorded at the abdominal surface of Beagle dogs with the aim of detecting the slow wave of small bowel myoelectrical activity. Electroeuterogram comprises two signals: the slow wave, which is permanently present and establishes the maximum rate of intestinal contraction, and a series of rapid activity peaks generated at the plateau of the slow wave when the small bowel contracts. Two biosignals were recorded using bipolar electrodes: the internal myoelectric signal at a point of the jejunum serosa, and the bioelectric signal at the abdominal wall. The coherence function was used to evaluate the relation between the spectral contents of the two signals (internal and external). The results show high coherence function values for frequencies of under 2 Hz. A maximum was even detected for a frequency round 0,3 Hz, corresponding to the frequency of the slow wave (between 16 and 19 cycles/min,). Based on the coherence function, it is shown that the signal recorded at the abdominal surface is closely related to the slow wave component of the internal signal. The model employed therefore offers a noninvasive technique for recording small bowel myoelectrical activity.
DTIC
Abdomen; Bioelectricity; Signal Processing; Wave Propagation; Recording Instruments

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FLUID MECHANICS AND THERMODYNAMICS

Includes fluid dynamics and kinematics and all forms of heat transfer; boundary layer flow; hydrodynamics; hydraulics; fluidics; mass transfer and ablation cooling. For related information see also *02 Aerodynamics*.

20030059519 NASA Marshall Space Flight Center, Huntsville, AL, USA
Turbine Air-Flow Test Rig CFD Results for Test Matrix
Wilson, Josh; 23 April 2003; 20 pp.; In English; MSFC Spring Fluids Workshop 2003, 22-24 Apr. 2003, Birmingham, AL, USA; No Copyright; Avail: CASI; A03, Hardcopy

This paper presents the Turbine Air-Flow Test (TAFT) rig computational fluid dynamics (CFD) results for test matrix. The

topics include: 1) TAFT Background; 2) Design Point CFD; 3) TAFT Test Plan and Test Matrix; and 4) CFD of Test Points. This paper is in viewgraph form.
CASI
Air Flow; Computational Fluid Dynamics; Turbines; Test Facilities; Aircraft Design

20030060421 NASA Marshall Space Flight Center, Huntsville, AL, USA
CFD-Based Design Optimization for Single Element Rocket Injector
Vaidyanathan, Rajkumar; Tucker, Kevin; Papila, Nilay; Shyy, Wei; [2003]; 21 pp.; In English; 41st Aerospace Sciences Meeting and Exhibit, 6-9 Jan. 2003, Reno, NV, USA; Copyright; Avail: CASI; A03, Hardcopy

To develop future Reusable Launch Vehicle concepts, we have conducted design optimization for a single element rocket injector, with overall goals of improving reliability and performance while reducing cost. Computational solutions based on the Navier-Stokes equations, finite rate chemistry, and the k-E turbulence closure are generated with design of experiment techniques, and the response surface method is employed as the optimization tool. The design considerations are guided by four design objectives motivated by the consideration in both performance and life, namely, the maximum temperature on the oxidizer post tip, the maximum temperature on the injector face, the adiabatic wall temperature, and the length of the combustion zone. Four design variables are selected, namely, H2 flow angle, H2 and O2 flow areas with fixed flow rates, and O2 post tip thickness. In addition to establishing optimum designs by varying emphasis on the individual objectives, better insight into the interplay between design variables and their impact on the design objectives is gained. The investigation indicates that improvement in performance or life comes at the cost of the other. Best compromise is obtained when improvements in both performance and life are given equal importance.
Author
Computational Fluid Dynamics; Injectors; Reusable Launch Vehicles; Design Optimization; Rocket Engines; Space Shuttle Main Engine

20030060492 Technical Research Centre of Finland, Espoo, Finland
Implementation and Evaluation of Air Flow and Heat Transfer Routines for Building Simulation Tools
Tuomaala, P.; 2002; 54 pp.; In English
Report No.(s): PB2003-105021; VTT-PUB-471; No Copyright; Avail: CASI; A04, Hardcopy

Environmental, epidemiological and economical reasons increase the pressure to design, construct and maintain better buildings in the future. Therefore, a new assembly of simulation routines for predicting both ventilation and heat transfer processes of building were studied. The work was limited to implementation and evaluation of new air flow and heat transfer routines for building simulation tools. Development of simulation tool user-interfaces, post-processors and component database have all been excluded.
NTIS
Buildings; Air Flow; Heat Transfer; Simulation

20030060505 Illinois Univ. at Urbana-Champaign, IL, USA
Nanoparticle Engineering of Complex Fluid Behavior
Lewis, Jennifer A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 366; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

A new mechanism for regulating the stability of colloidal particles has been discovered. Negligibly charged colloidal microspheres, which flocculate when suspended alone in aqueous solution, undergo a remarkable stabilizing transition upon the addition of critical volume fraction of highly charged nanoparticle species. Zeta potential analysis revealed that these microspheres exhibited an effective charge buildup in the presence of such species. Scanning angle reflectometry measurements indicated these nanoparticle species did not adsorb on the microspheres under the experimental conditions of interest. It is therefore proposed that highly charged nanoparticles segregate to regions near negligibly charged microspheres due to their repulsive Coulombic interactions in solution. This type of nanoparticle haloing provides a new method for tailoring the behavior of complex fluids, including its flow properties and structure.
Author
Colloids; Flow Characteristics; Research; Stabilization; Nanoparticles

20030060508 National Inst. of Standards and Technology, USA

Convective and Morphological Instabilities During Crystal Growth

McFadden, G. B.; Coriell, S. R.; Murray, B. T.; 2002 Microgravity Materials Science Conference; February 2003, pp. 408-417; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

During crystal growth or solidification of a binary alloy from a liquid phase, temperature and solute gradients are inherently present and can give rise to fluid flow in the melt. The interaction of fluid flow with the crystal-melt interface plays an important role in determining the properties of the solidified material. Convection in the melt and interface instability may both produce solute inhomogeneities. The coupling between morphological instability and fluid flow can be complicated; interfacial instabilities depend on temperature and solute gradients that may be strongly influenced by the flow field. The flow field, in turn, may be influenced by the morphology of the interface. A smooth crystal-fluid interface may become unstable during solidification, leading to cellular or dendritic growth. Linear morphological stability theory describes the conditions under which the interface becomes unstable. The original treatment of morphological stability by Mullins and Sekerka assumed local equilibrium at the crystal-melt interface and isotropy of the crystal-melt surface tension; this is an excellent approximation for many metals at low growth velocities. There have been many extensions of the theory in order to elucidate the role of external fields and additional physical effects on the stability demarcation. We discuss recent research on temperature-dependent solute diffusivity and electrical effects during growth of a binary alloy from the melt and on anisotropic kinetics and shear flows during growth from a supersaturated solution. For these cases, we consider the stability of a planar interface during constant velocity growth V in the z-direction. The base state depends only on the z coordinate. The interface and the relevant fields (temperature, concentration, and flow velocity) are perturbed and are assumed to depend on time t and the lateral directions x and y as exp[i (k(sub x)x+ k(sub y)y) + sigma t], where kx and ky are wavenumbers in the x and y directions and the complex quantity sigma = sigma(sub r) + i sigma (sub i) governs the time-behavior of the system. The interface is unstable if sigma(sub r) > 0 for any values of the wavenumbers kx and ky. We also discuss the effect of a fluid flow due to density change upon monotectic solidification. The separation of scales during dendritic growth of a binary alloy due to the large ratio of thermal and solutal diffusivity is also presented.
Author

Binary Alloys; Crystal Growth; Solidification; Interface Stability; Crystal Morphology; Thermal Diffusivity; Shear Flow

20030060517 Case Western Reserve Univ., Cleveland, OH, USA

Vibrations and G-jitter: Transport Disturbances Due to Residual Acceleration during Low Gravity Directional Solidification Experiments

Zhao, Y.; Gonzalez, R.; Alexander, J. Iwan D.; 2002 Microgravity Materials Science Conference; February 2003, pp. 14-25; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A03, Hardcopy

This research project is a four-year program of ground-based research. The proposed work involves both experimental and theoretical (numerical modeling) work. The experimental objectives are to characterize the response of heat and species transport in a directionally solidifying two-component melts (for both single and two-phase liquids) that are subject to well-characterized imposed vibrations and to spacecraft residual acceleration. The experimental work will focus on the examination of flow induced by applied vibration, (both uniform translational vibration and nonuniform vibration) and the consequences of this flow for heat and mass transport. To start we are restricting our investigation to simple systems and plan to extend our investigation to solidifying model alloys system during the last half of the program. The planned solidification experiments will use succinonitrile (SCN)-Water or SCN-Ethanol as a model alloy system. The temperature and composition fields will be measured using two-color holographic interferometry to characterize the composition and temperature fields. The convective flows will be visualized using a schlieren technique and selected experiments will involve Particle Image Velocimetry. For numerical modeling, for single-phase systems, we use the Navier-Stokes-Boussinesq equations for single-phase systems and the so-called Thermovibrational average equations for uniform and nonuniform vibration to investigate the role of vibration-induced mean flows. For two-liquid phase melts (for example, that occur in monotectics systems), we are exploring the possibility of using a Lattice Boltzmann approach. In this report, we discuss preliminary results for the generation of mean flows by vibration and effects on heat and mass transfer for microgravity and 1-g conditions. Mean flows caused by high frequency vibration are found by time averages of numerical simulations of the Navier-Stokes (NS) equations and from the thermovibrational mean flow equations developed by Gershuni et al. A quantitative investigation is carried out. Comparisons of time-averaged NS and the Gershuni equations are made for a wide range of parameters. The conditions for which the Gershuni equations should yield reliable predictions are explored. Based on the assumptions used to obtain the thermovibrational mean flow equations, the thermovibrational equations are valid when (2PrRa(sub nu))(exp 1/2) /Omega<<1. Here, Omega= omeagL(exp 2)/alpha is a dimensionless frequency and Ra(sub nu)=(((b)omega deltaTL)(exp

2))/2valpha is the vibrational Rayleigh number, and omega,L,b,deltaT,v and alpha are the vibration amplitude, the length of the container, the vibration amplitude, the characteristic temperature difference, the kinematic viscosity and the thermal diffusivity, respectively. In addition to the numerical modeling work, experimental work on the response of flow and transport vibration is in progress. The experimental set-up is described and planned experiments are discussed.
Author
Directional Solidification (Crystals); Vibration Effects; Acceleration (Physics); Microgravity; Heat Transfer; Mass Transfer; Convective Flow; Flow Visualization; Forced Vibration

20030060519 Florida Univ., Gainesville, FL, USA
Flow Visualization of Low Prandtl Number Fluids using Electrochemical Measurements
Crunkleton, D.; Anderson, T.; Narayanan, R.; Labrosse, G.; 2002 Microgravity Materials Science Conference; February 2003, pp. 33; In English; See also 20030060494
Contract(s)/Grant(s): NAG8-1679; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

It is well established that residual flows exist in contained liquid metal processes. In 1-g processing, buoyancy forces often drive these flows and their magnitudes can be substantial. It is also known that residual flows can exist during microgravity processing, and although greatly reduced in magnitude, they can influence the properties of the processed materials. Unfortunately, there are very few techniques to visualize flows in opaque, high temperature liquid metals, and those available are not easily adapted to flight investigation. In this study, a novel technique is developed that uses liquid tin as the model fluid and solid-state electrochemical cells constructed from Yttria-Stabilized Zirconia (YSZ) to establish and measure dissolved oxygen boundary conditions. The melt serves as a common electrode for each of the electrochemical cells in this design, while independent reference electrodes are maintained at the outside surfaces of the electrolyte. By constructing isolated electrochemical cells at various locations along the container walls, oxygen is introduced or extracted by imposing a known electrical potential or passing a given current between the melt and the reference electrode. This programmed titration then establishes a known oxygen concentration boundary condition at the selected electrolyte-melt interface. Using the other cells, the concentration of oxygen at the electrolyte-melt interface is also monitored by measuring the open-circuit potentials developed between the melt and reference electrodes. Thus the electrochemical cells serve to both establish boundary conditions for the passive tracer and sense its path. Rayleigh-Benard convection was used to validate the electrochemical approach to flow visualization. Thus, a numerical characterization of the second critical Rayleigh numbers in liquid tin was conducted for a variety of Cartesian aspect ratios. The extremely low Prandtl number of tin represents the lowest value studied numerically. Additionally, flow field oscillations are visualized and the effect of tilt on convecting systems is quantified. Experimental studies of the effect of convection in liquid tin are presented. Three geometries are studied: (1) double electrochemical cell with vertical concentration gradients; (2) double cell with horizontal concentration gradients; and (3) multiple cells with vertical temperature gradients. The first critical Rayleigh number transition is detected with geometry (1) and it is concluded that current measurements are not as affected by convection as EMF measurements. The system is compared with numerical simulations in geometry (2), and oscillating convection is detected with geometry (3).
Author
Flow Visualization; Rayleigh-Benard Convection; Solid Electrolytes

20030060523 Alabama Univ., Huntsville, AL, USA
Convective Effects During Diffusivity Measurements in Liquids with An Applied Magnetic Field
Khine, Yu Yu; Banish, R. Michael; Alexander, J. Iwan D.; 2002 Microgravity Materials Science Conference; February 2003, pp. 42-52; In English; See also 20030060494; Original contains black and white illustrations
Contract(s)/Grant(s): NCC8-94; NAG8-1476; No Copyright; Avail: CASI; A03, Hardcopy

Convective contamination of self-diffusion experiments with an applied magnetic field is considered using a two-dimensional axisymmetric model. Constant, uniform, and an additional non-uniform heat fluxes are imposed along the sidewall of the cylinder while constant heat loss occurs through the top and bottom. In this model, due to a very small thermal Peclet number, convective heat transfer is neglected, and the flow is steady and inertialess. Time-dependent concentration is solved for various values of the mass Peclet number, Pe(sub m), (the ratio between the convective transport rate and the diffusive transport rate) and different magnetic field strengths represented by the Hartmann number Ha. Normalized values of these diffusivities vs. effective Pe(sub m) are presented for different imposed temperature profiles. In all cases, the diffusivity value obtained through the simulated measurement increases as the effective Pe(sub m) increases. The numerical results

suggest that an additional periodic flux, or hot and cold spots, can significantly decrease the convective contamination in our geometry.
Author
Diffusivity; Heat Flux; Magnetic Fields; Magnetic Flux; Two Dimensional Models; Convective Flow

20030060531 Minnesota Univ., Minneapolis, MN, USA
Modeling Three-dimensional Flows and G-Jitter During Microgravity Bridgman Growth
Derby, Jeffrey J.; Pandy, Arun; Yeckel, Andrew; 2002 Microgravity Materials Science Conference; February 2003, pp. 167; In English; See also 20030060494; No Copyright; A01, Hardcopy; Abstract Only; Available from CASI only as part of the entire parent document

Buoyancy-driven melt convection dominates mass transport in many crystal growth systems, thereby having a critical effect on solute segregation. Since segregation in turn plays a key role in determining the properties of grown materials, there is widespread interest in the application of various methods to modify or suppress convection. In this vein, microgravity crystal growth promises great benefits for better understanding and control of buoyant flow. However, even small changes in acceleration (i.e., g-jitter) can drive flows significant enough to affect segregation. We present an overview of a new finite element model for the parallel computation of three-dimensional flows, segregation, and solidification during Bridgman crystal growth. The model features a self-consistent coupling between the field phenomena (fluid flow, heat and mass transfer) and interfacial effects (solidification) via front-tracking techniques. Also of note is a new coupling with a sophisticated furnace model, the CrysVUN++ code of Mueller et al., to provide realistic heat transfer boundary conditions. We present initial results for several three-dimensional systems, including an ground-based horizontal Bridgman system and a prototype system for microgravity and g-jitter.
Author
Three Dimensional Flow; Vibration; Microgravity; Bridgman Method; Mathematical Models; Crystallization

20030060539 Stanford Univ., Stanford, CA, USA
Investigation Of The Crystal Growth Of Dielectric Materials By The Bridgman Technique Using Vibrational Control
Feigelson, Robert S.; Zharikov, Evgenii V.; 2002 Microgravity Materials Science Conference; February 2003, pp. 220; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Fluid convection is an important phenomenon in crystal-melt systems. When uncontrolled, it can lead to a variety of problems including the incorporation of defects into a growing crystal. In a microgravity environment, where solutal and thermal convection is minimal, g-jitter, random vibrations produced from various sources, has been found to cause undesirable fluid flow. One potential solution to this problem involves the introduction of precisely controlled convection to suppress these flows. Forced convection is already used in many earth-based crystal growth processes to improve crystal quality and growth rates by either inducing or suppressing the naturally occurring convection. This research program has focused on convection induced through the application of low-frequency vibrations, either directly into the melt with a vibrating disk (applied vibrational control [AVC]), or external to the growth ampoule (coupled vibrational stirring). Both vibrational techniques produce significant convection, and the benefits/drawbacks of each technique will be discussed. A water/glycerin system was used to determine important vibrational parameters and to make quantitative measurements of fluid flow produced through vibrations. Fluid flow was imaged with the aid of tracer particles. Important dependent variables such as fluid velocity profiles were measured as a function of vibrational settings, crucible geometry, and fluid properties. The influence of vibrational flow was investigated in NaNO3, a low temperature (306 C) growth system that could be directly observed with the aid of a transparent furnace. Effects on growth rate, interface shape and position, and doping profiles were observed. The effect of these techniques was also examined in high temperature systems (lead magnesium niobate-lead titanate for CVS and lead telluride for AVC).
Author
Crystal Growth; Random Vibration; Fluid Flow; Convection; Dielectrics; Melts (Crystal Growth); Forced Convection

20030060544 Pennsylvania State Univ., University Park, PA, USA
Gravitational Effects on Distortion in Sintering
German, Randall M.; 2002 Microgravity Materials Science Conference; February 2003, pp. 231-236; In English; See also 20030060494
Contract(s)/Grant(s): NAG8-1452; No Copyright; Avail: CASI; A02, Hardcopy

During sintering a powder compact gains strength through low-temperature interparticle bonding, usually induced by

solid-state surface diffusion, followed by further strength contributions from high-temperature densification. In cases where a liquid phase forms, sintering densification is accelerated and shape retention is sustained while open pores remain and contribute capillary forces. Unfortunately, sintering densification requires the compact become thermally softened to a point where creep strain rates reach levels near 10(exp -2)/s when the liquid forms. On the other hand, thermal softening of the powder compact substantially reduces the strength at high temperatures. Therefore, the in situ strength evolution during sintering is a primary focus to separate compact densification (as required for high performance) with minimized distortion (as required for net-shaping). With respect to gravitation effects on distortion during sintering there are two points of substantial weakness - prior to significant interparticle bonding and during final pore closure. This research is focused on understanding the competition among interparticle neck growth, densification, thermal softening, grain boundary wetting, capillary effects associated with liquid wetting and residual porosity, and gravity. Most surprising is the apparent role of gravity, where the deviatoric stress acting on the powder structure induces skeletal formation that reduces distortion. In contrast with theory, microgravity samples exhibit more distortion yet fail to fully densify. Results are presented on the experimental concepts supporting an emerging model of sintering strength evolution that enables understanding of both distortion and densification. The experiments have relied on tungsten heavy alloys, various combinations of dihedral angle, pore size, initial porosity, liquid:solid ratio, and heating rates. On Earth, the dominant factor with respect to distortion is the starting body heterogeneity. Current modeling efforts are seeking some means to uniformly predict the distortion based on a starting pore structure heterogeneity parameter. Densification is largely unaffected by the initial pore structure, but distortion is highly variable, suggesting that nonuniform pore closure might be a significant parameter during sintering. With respect to flight experiments, plans include removal of the solid body forces acting on the solid grains, allowing stabilization of the pore structure and examination of the buoyancy effects with regard to distortion. In microgravity there is the surprising result that compacts do not densify, yet distort a factor that is contrary to all current sintering models. Densification without distortion during liquid phase sintering was achieved by manipulating microstructure and its evolution during sintering. Microstructure parameters such as the solid volume fraction, dihedral angle, initial porosity, and pore size were varied to measure densification and distortion behavior during LPS using W-Ni-Cu alloys. Green compacts were formed using ethylene-bis-stearamide as a pore-forming agent with the amount of polymer controlling the initial porosity. Different initial pore sizes were generated by varying the polymer particle size. Dihedral angle was varied by changing the Ni:Cu ratio in the alloys. Finally, the solid volume fraction was adjusted via the tungsten content. Distortion was quantified using profiles determined with a coordinate measuring machine to calculate a distortion parameter. Sintering results showed that solid volume fraction and dihedral angle are the dominant factors on densification and distortion during liquid phase sintering. Distortion decreases with increasing solid volume fraction and dihedral angle, while initial porosity and pore size have no observable effect on distortion at nearly full densification. Various strategies emerge to improve distortion control in liquid phase sintering.
Author
Sintering; Gravitational Effects; Powder (Particles); Porosity; Distortion; High Temperature; Densification

20030060563 University of Southern Mississippi, MS, USA
Transient Interfacial Phenomena in Miscible Polymer Systems (TIPMPS)
Pojman, John A.; Bessonov, Nicholas; Volpert, Vitaly; Wilke, Hermann; 2002 Microgravity Materials Science Conference; February 2003, pp. 464-474; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAG8-1466; No Copyright; Avail: CASI; A03, Hardcopy

Almost one hundred years ago Korteweg published a theory of how stresses could be induced in miscible fluids by concentration gradients, causing phenomena that would appear to be the same as with immiscible fluids. Miscible fluids could manifest a transient or effective interfacial tension (EIT). To this day, there has been no definitive experiment to confirm Korteweg's model but numerous fascinating and suggestive experiments have been reported. The goal of TIPMPS is to answer the question: Can concentration and temperature gradients in miscible materials induce stresses that cause convection? Many polymer processes involving miscible monomer and polymer systems could be affected by fluid flow and so this work could help understand miscible polymer processing, not only in microgravity, but also on earth. Demonstrating the existence of this phenomenon in miscible fluids will open up a new area of study for materials science. The science objectives of TIPMPS are: (1) Determine if convection can be induced by variation of the width of a miscible interface; (2) Determine if convection can be induced by variation of temperature along a miscible interface; (3) Determine if convection can be induced by variation of conversion along a miscible interface An interface between two miscible fluids can best be created via a spatially-selective photopolymerization of dodecyl acrylate with a photoinitiator, which allows the creation of precise and accurate concentration gradients between polymer and monomer. Optical techniques will be used to measure the refractive index variation caused by the resultant temperature and concentration fields. The viscosity of the polymer will be measured from the increase in the fluorescence of pyrene. Because the large concentration and temperature gradients cause buoyancy-driven convection that

prevents the observation of the predicted flows, the experiment must be done in microgravity. In this report, we will consider our efforts to estimate the square gradient parameter, k, and our use of the estimates in modeling of the planned TIPMPS experiments. We developed a model consisting of the heat and diffusion equations with convective terms and of the Navier-Stokes equations with an additional volume force written in the form of the Korteweg stresses arising from nonlocal interaction in the fluid. The fluid's viscosity dependence on polymer conversion and temperature was taken from measurements of poly(dodecyl acrylate). Numerical modeling demonstrated that significant flows would arise for conditions corresponding to the planned experiments.
Author
Convection; Binary Systems (Materials); Phase Transformations; Solubility; Interfacial Tension; Fluid Flow; Temperature Gradients; Concentration (Composition)

20030060571 Massachusetts Univ., Amherst, MA, USA
Surface and Interfacial Structures Induced By Electrodhydrodynamic Instabilities
Russell, Thomas P.; Lin, Zhi-Qun; Kerle, Tobias; Hoagland, David A.; Schaeffer, Erik; Steiner, Ullrich; Mays, Jimmy W.; 2002 Microgravity Materials Science Conference; February 2003, pp. 510-520; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

It is well known that there is thermally excited capillary wave at the interface, where the amplitude and wavelength are governed by the interfacial tension and any pressures acting on the in interface including gravity. An external electric field applied across the interface exerts an electrostatic pressure on the interface that will amplify the fluctuations. The electrostatic pressure works against interfacial tension, which is given by the product of the interfacial energy and the interface area, to generate the electrohydrodynamic instabilities. The small wavelength fluctuations are suppressed since they are too costly energetically. The long wavelength fluctuations, on the other hand, are also suppressed due to the fluid dynamics. This leads to the fastest growth of one wavelength, which is amplified, and eventually bridges between two electrodes. The indium-tin-oxide coated (ITO) microscope slides is served as the upper electrode. It is transparent and good for real time optical microscopy observations. The separation distance between Si substrate and ITO glass can be controlled by evaporating thin rails of SiO(x) on the top of ITO glass or Si substrate as an insulating spacer. In the case of single layer film and bilayer studies, the medium 1 and the medium 2 are air/liquid, and liquid 1/liquid 2, respectively.
Derived from text
Fluid Dynamics; Capillary Waves; Electrohydrodynamics; Interfacial Tension

20030060572 University of Southern California, Los Angeles, CA, USA
Non-Intrusive Measurement of Thermophysical Properties of Liquids by Electrostatic-Acoustic Hybrid Levitation
Sadhal, S. S.; Ohsaka, K.; Rednikov, A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 531-547; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

In the current task, we have developed a novel technique that can be used to determine the viscosity and surface tension of highly viscous liquids levitated with an ultrasonic levitator. The technique involves levitation of a liquid drop and elongation by rotating the drop beyond the point of bifurcation. The elongated drop is then relaxed and allowed to restore itself to its original shape by surface tension. The time-dependent shape parameters of the relaxing drop are related to the viscosity through a relaxation model. The feasibility of the technique has been demonstrated by performing the measurement using sucrose solutions as a model liquid drop. The obtained viscosity values show a good correlation with those determined by a falling ball method, a proven technique. The ultrasonic levitator did not have capability to allow the variation of the We have also developed a method that can be used to determine the thermal diffusivity coefficient of undercooled liquids. The technique involves levitation of a small amount of liquid in the shape of a flattened drop using an acoustic levitator and heating it with a laser beam. The heated drop is then allowed to cool naturally by heat loss from the surface. Due to acoustic streaming, the heat loss mainly occurs through the equatorial section of the drop. The measured cooling rate in combination with a radial heat condition model allows us to determine the thermal diffusivity coefficient of the drop. We demonstrated the feasibility of the technique using glycerin drops as a model liquid. The agreement between the experiment and the model turns out to be fair at best. The reason is mainly due to the inadequacies of the 1-D heat conduction model used, and other surface-loss approximations. Thermocapillary flow measurements of drastically flattened drops have been initiated in the current task. The drastically flattened drop has flows that are dominated by thermocapillary forces because the buoyancy-driven flows are mitigated owing to the low hydrostatic head over the drop thickness. As a result, there is minimal interference from the natural convection, and with thermocapillary flow being isolated, some thermal properties can be inferred from the measurements. We have demonstrated the technique using a glycerin drop that is acoustically levitated and flattened using an acoustic apparatus. Theoretical analysis of streaming flows about liquid drops and solid particles have been carried out in connection with

levitation. The present study deals with the steady streaming in the incompressible limit around a rigid oblate spheroid that performs translational oscillations relative to the fluid medium along its symmetry axis. Motivation for such a study is two-fold. On the one hand, liquid drops are known to be squeezed to an oblate shape, quite close to an oblate spheroid, when levitated in acoustic levitators at sufficiently high intensities of the sound field. Due to their large density and dynamic viscosity as compared to those of the surrounding air, the drops may behave to a high degree as rigid bodies streaming-wise. In particular, the influence of the acoustically induced internal circulation in a drop on the steady streaming in the air can be estimated. On the other hand, the study of the streaming around a body more complex than a sphere may also be important from an intrinsic standpoint, especially in view of our intention to consider the disk limit. The choice of the oblate spheroid for this purpose is convenient in view of the availability of the oblate spheroidal coordinate system.
Author
Acoustic Levitation; Thermal Diffusivity; Viscosity; Interfacial Tension; Acoustic Streaming; Electrostatics

20030060580 NASA Marshall Space Flight Center, Huntsville, AL, USA
Small Particle Response to Fluid Motion Using Tethered Particles to Simulate Microgravity
Trolinger, James; L'Esperance, Drew; Rangel, Roger; Coimbra, Carlos; Witherow, William K.; Rogers, Jan; Lal, Ravindra; 2002 Microgravity Materials Science Conference; February 2003, pp. 643-654; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAS8-98091; No Copyright; Avail: CASI; A03, Hardcopy

This paper reports on ground based work conducted to support the Spaceflight Definition project SHIVA (Spaceflight Holography Investigation in a Virtual Apparatus). SHIVA will advance our understanding of the movement of a particle in a fluid. Gravity usually dominates the equations of motion, but in microgravity as well as on earth other terms can become important. Through an innovative application of fractional differential equations, two members of our team produced the first analytical solution of a fundamental equation of motion, which had only been solved numerically or by approximation before. The general solution predicts that the usually neglected history term becomes important in particle response to a sinusoidal fluid movement when the characteristic viscous time is in the same order as the fluid oscillation period and peaks when the two times are equal. In this case three force terms, the Stokes drag, the added mass, and the history drag must all be included in predicting particle movement. We have developed diagnostic recording methods using holography to save all of the particle field data, allowing the experiment to essentially be transferred from space back to earth in what we call the virtual apparatus for on-earth microgravity experimentation. We can quantify precisely the three-dimensional motion of sets of particles, allowing us to test and apply the new analytical solutions. We are examining the response of particles up to 2 mm radius to fluid oscillation at frequencies up to 80 Hz with amplitudes up to 200 microns. Ground studies to support the flight development program have employed various schemes to simulate microgravity. One of the most reliable and meaningful methods uses spheres tethered to a fine hair suspended in the fluid. We have also investigated particles with nearly neutral buoyancy. Recordings are made at the peak amplitudes of vibration of the cell providing a measure of the ratio of fluid to particle amplitude. The experiment requires precise location of the particle to within microns during recording, and techniques for achieving this are one of the project challenges. Focused microscopic images and diffraction patterns are used. To make the experiment more versatile, the spaceflight system will record holograms both on film and electronically. A cross correlation procedure enables sub pixel accuracies for electronic recordings, partially accommodating the lower spatial resolution of CCDs. The electronic holograms can be down linked providing real time data. Results of the ground experiments, the flight experiment design, and data analysis procedures are reported.
Author
Particle Motion; Stokes Flow; Microgravity; Holography; Computational Fluid Dynamics; Equations Of Motion; Differential Equations

20030060584 Containerless Research, Inc., Evanston, IL, USA
Microgravity Studies of Liquid-liquid Phase Transition in Undercooled Alumina-Yttria Melts
Weber, Richard; Nordine, Paul; 2002 Microgravity Materials Science Conference; February 2003, pp. 682-687; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

This research concerns the behavior of molten pseudo-binary alumina-yttria (A-Y, Al2O3-Y2O3) materials under non-equilibrium conditions. These oxides form liquids with a highly non-Arrhenian temperature/viscosity relationship, some compositions undergo a polyamorphic liquid phase transition to form two immiscible liquids. When the liquid mixtures are quenched, two-phase glasses are formed in which both phases have virtually identical chemical compositions. The A-Y based glasses are of interest for laser and optical applications and they are of fundamental and applied interest in materials science. The overall goal of this investigation is to increase understanding of phase behavior in oxide liquids, better understand the

nature of liquid phase transitions, and investigate the way in which the melt viscosity changes with temperature. Low gravity experiments are of interest because they can access pristine and quiescent liquid samples needed to investigate subtle changes in liquid properties. The ground-based flight definition research is being performed in facilities that access the highly non-equilibrium liquid by using containerless techniques. This research has led to development of new high-dopant content optical glass materials which are being commercialized in separate work. Liquids and glasses are being characterized as a function of the process conditions and the viscosity of the liquids is being investigated using stinger and drop oscillation techniques at CRI and in collaboration with scientists at NASA and NASDA. The structure and properties of the glasses are being studied in collaborative investigations using scanning electron microscopy, X-ray and neutron diffraction, 27Al NMR, thermal analysis, and optical spectroscopy. A model of the liquid structure is being developed. Main findings of the work are summarized below: (1) The undercooling limit for the liquid of the YAG-composition (under containerless conditions) is ca. 0.58 times the melting point of the crystal; (2) The phase transition occurs via changes in the connectivity of the Al-O and Y-O coordination polyhedra and changes in Y-O coordination which preserve stoichiometry; (3) Processing and composition changes which promote formation of predominantly 4-coordinate Al3+ ions tend to stabilize single phase glasses; (4) Based on limited viscosity data, the fragility index of the liquids is 0.43-0.65. The glass transition temperatures are practically constant over the range of A-Y materials studied. Activities were focused on detailed characterization of the structure and properties of single- and two-phase glasses to establish the experimental requirements for development of a fuller understanding of the liquid-liquid phase transition in the ionic alumina-yttria liquids. The research is developing a precise analysis of the requirements for low gravity experiments on A-Y liquids needed to study the phase transition kinetics.
Author
Glass; Microgravity; Phase Transformations; Containerless Melts; Viscosity; Yttrium Oxides; Supercooling; Kinetics

20030060622 NASA Langley Research Center, Hampton, VA, USA
CFD Sensitivity Analysis of a Drag Prediction Workshop Wing/Body Transport Configuration
Lee-Rausch, E. M.; Buning, P. G.; Morrison, J. H.; Park, M. A.; Rivers, S. M.; Rumsey, C. L.; Mavriplis, D.; [2003]; 15 pp.; In English; 21st AIAA Applied Aerodynamics Conference, 23-26 Jun. 2003, Orlando, FL, USA
Report No.(s): AIAA Paper 2003-3400; Copyright; Avail: Other Sources

The current work re-visits calculations for the First AIAA Drag Prediction Workshop (DPW-I) configuration and uses a grid convergence study to evaluate the quantitative effects of discretization error on the code-to-code variation of forces and moments. Four CFD codes commonly used at NASA Langley Research Center are used in the study: CFL3D and OVERFLOW are structured grid codes, and NSU3D and FUN3D are unstructured grid codes. Although the drag variation reported in the summary of DPW-I results was for the constant- lift cruise condition, the focus of the current grid convergence study is a constant angle-of-attack condition (alpha = 0 deg) near the same cruise lift in order to maintain identical boundary conditions for all of the CFD codes. Forces and moments were computed on the standard DPW-I structured overset and node-based unstructured grids, and the results were compared for the required transonic drag polar case. The range in total drag predicted using the workshop standard grids at alpha = 0 deg was 14 counts. The variation of drag in terms of standard deviation was 6 counts. Additional calculations at alpha = 0 deg were performed on the two families of structured and Unstructured grids to evaluate the variation in forces and moments with grid refinement. The structured grid refinement study was inconclusive because of difficulties computing on the fine grid. The grid refinement study for the unstructured grid codes showed an increase in variation of forces and moments with grid refinement. However, all of the unstructured grid results were not definitively in the range of asymptotic grid convergence. The study indicated that certain numerical schemes (central vs. upwind, thin-layer vs. full viscous) or other code-to-code differences may have a larger effect than previously thought on grid sizes considered to be ‘medium’ or ‘fine’ by current standards.
Author
Computational Fluid Dynamics; Drag; Predictions; Sensitivity Analysis

20030060659 NASA Marshall Space Flight Center, Huntsville, AL, USA
The Effect of Rotating a Faraday Disc Perpendicular to an Applied Magnetic Field Theory and Experiment
Mazuruk, Konstantin; Grugel, Richard N.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

A magnetohydrodynamic model that examines the effect of rotating an electrically conducting cylinder with a uniform external magnetic field applied orthogonal to its axis is presented. Noting a simple geometry, it can be classified as a fundamental dynamo problem. For the case of an infinitely long cylinder, an analytical solution is obtained and analyzed in detail. A semi-analytical model was developed that considers a finite cylinder. Experimental data from a spinning brass wheel

in the presence of Earth's magnetic field were compared to the proposed theory and found to fit well.
Author
Magnetohydrodynamics; Mathematical Models; Magnetic Fields; Rotating Generators

20030061076 Air Force Research Lab., Edwards AFB, CA, USA
Current Status of Gas/Gas Injector Research at AFRL
Archambault, Mark; Talley, Douglas; Peroomian, Oshin; Oct. 2001; 11 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410871; AFRL-PR-ED-TP-2001-193; No Copyright; Avail: CASI; A03, Hardcopy

A computational and experimental program of research in gas/gas injection has been initiated in support of staged combustion cycle engines such as the H2/O2 Integrated Powerhead Demo or a staged combustion hydrocarbon boost engine. The overall objective of this research is to develop a design methodology for gas/gas injectors. By taking the approach of using experimental measurements to anchor state-of-the-art flow codes, we gain confidence in their predictive capabilities. This in turn leads to a more efficient design process which results in significant sayings in full-scale development time and costs. This paper focuses on a computational methodology to efficiently, accurately, and robustly obtain high-fidelity solutions of combusting rocket engine flows to gain a knowledge and understanding of their features. To that end, simulations of a combusting, single-element, shear-coaxial, H2/O2 engine were performed to characterize its flowfield and to validate the CFD++ flow solver for this class of problems. Both steady and transient solutions are examined and compared to experimental data to help determine the accuracy of the code.
DTIC
Computational Fluid Dynamics; Injectors

20030061120 Texas Univ., Arlington, TX, USA
DNS/LES Progress and Challenges: Proceedings of the Third AFOSR international Conference on DNS/LES
Liu, Chaoqun; Sakell, Leonidas; Beutner, Thomas; Dec. 15, 2001; 899 pp.; In English
Contract(s)/Grant(s): F49620-01-1-0065
Report No.(s): AD-A412801; AFRL-SR-AR-TR-02-0416; No Copyright; Avail: CASI; A99, Hardcopy

This is the third time for worldwide DNS/LES experts to get together to introduce research progress, exchange ideas, and discuss future research directions since the US Air Force Office of Scientific Research (AFOSR) sponsored the First AFOSR. International Conference on DNSILES (FAICDL) at Louisiana Tech University in 1997. The second conference was held at Rutgers -The State University of New Jersey in 1999. I am very pleased that many scientists and engineers are interested in this conference. I have received over 90 regular papers, in addition to 19 invited papers. It clearly shows that the DNS/LES community is much larger than ever before. Significant progress has been achieved during the past decade. It is difficult to give a complete review in this area. People may take a reference from reviews by Moin & Mehesh (1998) for DNS and Leseiur & Metais (1996) and Piomelli (1999) for LES. Sagaut (2000) just published a LES book, which gives discussions on many issues related to LES. It is also very difficult to invite all of the important contributors to give invited lectures for the conference. During this conference, Germano will give a review on LES; Visbal and Gatski will talk about Air Force and NASA needs on DNSILES and their applications; Sagaut, Kato, and Shan will talk about complicated configurations and industrial application; Jolsin will talk about DNS for flow control; Adams and Thong about high speed flow transitions; Givi about LES for reacting flow, Shu and Jiang about high order discretization, Karniadakis about DNS for unstructured grids; Vasilyev about some important LES constrains. In addition, Knight, Piomelli, Satofuka, Verstappen will also give lectures about their own distinguished work.
DTIC
Conferences; Vortices

20030061128 Engineering Research and Consulting Inc (ERC Inc) Edwards AFB CA, Edwards AFB, CA, USA
Coaxial Injection under Supercritical Conditions
Chehroudi, Bruce; Talley, Doug; January 2003; 3 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A410921; AFRL-PR-ED-AB-2002-124; No Copyright; Avail: CASI; A01, Hardcopy

This work reports on findings from the initial phase of a coaxial injection process under both subcritical and supercritical conditions. The results presented here are part of a systematic investigation of common rocket engine injectors, such as impinging and coaxial designs. Liquid nitrogen (LN2) is injected through a large length-to-diameter ratio circular hole and

exposed at the exit to an annular jet of different gases including nitrogen, helium, and argon. The length-to-diameter ratio is sufficiently large to ensure fully-developed turbulent pipe flow at the exit plane. The behavior of the central LN2 jet has already been analyzed extensively and reported in our earlier published works, for example, Cheliroudi et al. 1, 2. Experiments were conducted by injecting LN2 into a room temperature, high-pressure chamber with full optical access from four directions. The stainless steel chamber can withstand pressures and temperatures of up to 13.6 MPa and 473 K, respectively. Liquid nitrogen is used to cool and/or liquefy the gaseous nitrogen passing through the cryogenic cooler prior to injection. The mass flow rate of the injectant is measured and regulated by way of a mass flowmeter, and a precision micrometer valve. A model K2 Infinity long distance microscope is used to form images of the injected jets on a high resolution CCD camera by the Cooke Corporation.
DTIC
Injection; Supercritical Flow; Liquid Nitrogen; Rocket Engines; Coaxial Flow

20030061202 NASA Marshall Space Flight Center, Huntsville, AL, USA
Overview of MSFC's Applied Fluid Dynamics Analysis Group Activities
Garcia, Roberto; Griffin, Lisa; Williams, Robert; [2002]; 12 pp.; In English; MSFC Fall Fluids Workshop, 19-21 Nov. 2002, Huntsville, AL, USA; No Copyright; Avail: CASI; A03, Hardcopy

This viewgraph report presents an overview of activities and accomplishments of NASA's Marshall Space Flight Center's Applied Fluid Dynamics Analysis Group. Expertise in this group focuses on high-fidelity fluids design and analysis with application to space shuttle propulsion and next generation launch technologies. Topics covered include: computational fluid dynamics research and goals, turbomachinery research and activities, nozzle research and activities, combustion devices, engine systems, MDA development and CFD process improvements.
CASI
Computational Fluid Dynamics; NASA Programs; Research Facilities; Turbomachinery; Systems Engineering; Design Analysis; Spacecraft Propulsion

20030061241 NASA Marshall Space Flight Center, Huntsville, AL, USA
Overview of MSFC's Applied Fluid Dynamics Analysis Group Activities
Garcia, Roberto; Griffin, Lisa; Williams, Robert; [2003]; 14 pp.; In English; MSFC Spring Fluids Workshop, 23 Apr. 2003, Birmingham, AL, USA; No Copyright; Avail: CASI; A03, Hardcopy

TD64, the Applied Fluid Dynamics Analysis Group, is one of several groups with high-fidelity fluids design and analysis expertise in the Space Transportation Directorate at Marshall Space Flight Center (MSFC). TD64 assists personnel working on other programs. The group participates in projects in the following areas: turbomachinery activities, nozzle activities, combustion devices, and the Columbia accident investigation.
CASI
Fluid Dynamics; NASA Programs; Research And Development

20030061242 Pennsylvania State Univ., University Park, PA, USA
Sea-Level Static Testing of the Penn State Two-Dimensional Rocket-Based Combined Cycle (RBCC) Testbed
Cramer, J. M.; Marshall, W. M.; Pal, S.; Santoro, R. J.; January 2003; 11 pp.; In English; PERC 14th Annual Symposium on Propulsion, 10-11 Dec. 2002, University Park, PA, USA
Contract(s)/Grant(s): NAS8-40890; No Copyright; Avail: CASI; A03, Hardcopy

Twin thruster tests have been conducted with the Penn State RBCC test article operating at sea- level static conditions. Significant differences were observed in the performance characteristics for two different thruster centerline spacings. Changing the thruster spacing from 2.50 to 1.75 in. reduced the entrained air velocity (-17\%) and the thrust (-7\%) for tests at a thruster chamber pressure of 200 psia and MR = 8. In addition, significant differences were seen in the static pressure profiles, the Raman spectroscopy profiles, and the acoustic power spectrum for these two configurations.
Author
Rocket-Based Combined-Cycle Engines; Sea Level; Static Tests; Two Dimensional Models; Computational Fluid Dynamics; Test Stands; Aerodynamic Configurations

20030061246 NASA Marshall Space Flight Center, Huntsville, AL, USA
Experiments on Suppression of Thermocapillary Oscillations in Float-Zones by High-Frequency End-Wall Vibrations
Anilkumar, A. V.; Grugel, R. N.; Lee, C. P.; Bhowmick, J.; Wang, T. G.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Experiments to suppress thermocapillary oscillations using high-frequency vibrations were performed on float-zones. Such a float-zone is formed by melting one end of a vertically held sodium nitrate-barium nitrate crystal rod in contact with a hot surface at the top. In the experiments, when thermocapillary oscillation occurred, the bottom end of the rod was vibrated at a high frequency to generate fine ripples on the melt surface, driving a streaming flow in the opposite direction to that of the thermocapillary convection. It was observed that by generating a sufficiently strong streaming flow the thermocapillary flow can be offset enough such that the associated thermocapillarity oscillations can be quenched.
Author
Thermocapillary Migration; Oscillations; Walls; Capillary Flow; Float Zones; Retarding

20030061275 Air Force Research Lab., Edwards AFB, CA, USA
Momentum Flux Measurements from Under Expanded Orifices: Applications for Micropropulsion Systems
Ketsdever, Andrew D.; Green, Amanda A.; Muntz, E. P.; Jan. 11, 2001; 24 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A410837; AFRL-PR-ED-TP-2001-005; No Copyright; Avail: CASI; A03, Hardcopy

The popularity of micropropulsion system development has led to renewed interest in the determination of propulsive properties of orifice flows since micronozzle expansions ma suffer high viscous losses at low pressure operation. The mass flow and relative thrust through an underexpanded orifice is measured as a function of orifice stagnation pressure from 0.1 to 3.5 Torr. Nitrogen, argon, and helium propellant gases are passed through a 1.0 mm diameter orifice with a wall thickness of 0.015 mm. Near-free molecule, transitional and continuum flow regimes are studied. The relative thrust is determined by measuring the displacement of a novel thrust stand designed primarily for low operating pressure propulsion systems. It is shown that the thrust stand deflection is a function of the facility background pressure, and corrections are made to determine the deflection for a zero background pressure for a nitrogen propellant.
DTIC
Orifices; Microrocket Engines; Flux (Rate); Nozzles

20030061280 California Univ Los Angeles Dept. of Mechanical and Aerospace Engineering, Los Angeles, CA, USA
DNS Studies of Transitional Hypersonic Reacting Flows Over 3-D Hypersonic Vehicles
Zhong, Xiaolin; Mar. 5, 2003; 54 pp.; In English
Contract(s)/Grant(s): F49620-00-1-0101
Report No.(s): AD-A412861; AFRL-SR-AR-TR-03-0104; No Copyright; Avail: CASI; A04, Hardcopy

The objectives of this research project are to develop CFD techniques and to conduct DNS studies of fundamental flow physics leading to boundary-layer instability and transition in hypersonic flows. During the three-period, we have conducted extensive DNS studies on the receptivity of a supersonic boundary layer over a blunt cone, and over both sharp and blunt leading edge; and on the receptivity of the Gortler vortices. DNS studies were also compared with Stetson's-l984 stability experiment on Mach 7.99 flow over a blunt cone. Our studies have led to new understanding of a number of hypersonic boundary layer receptivity mechanisms. Such understanding can lead to better tool for the prediction and control of high-speed boundary layer transition.
DTIC
Boundary Layer Transition; Hypersonic Vehicles

20030061290 NASA Marshall Space Flight Center, Huntsville, AL, USA
MSFC Turbomachinery Fluid Dynamics Roadmap
Griffin, Lisa W.; April 22, 2003; 33 pp.; In English; MSFC Spring Fluids Workshop, 22-24 Apr. 2003, Birmingham, AL, USA; No Copyright; Avail: CASI; A03, Hardcopy

This viewgraph presentation provides an overview of future research issues and objectives of the Marshall Space Flight Center's Turbomachinery Fluid Dynamics team. Research focuses on developing and enhancing aerodynamic and hydrodynamic design tools and computational fluid dynamics (CFD) analysis tools, applying these tools to development of hardware technology and concepts, and defining cold flow experiments to provide tool validation, technology and concept verification, and to further expand fluid dynamics knowledge and understanding.
CASI
Research Facilities; Computational Fluid Dynamics; NASA Programs; Turbomachinery; Fluid Dynamics

20030061352 Illinois Univ., Urbana, IL, USA

Experimental Studies of High-Speed Separated Flows

Dutton, J. C.; Grafton, W.; Williams, Lillian B.; Mar. 2002; 489 pp.; In English

Contract(s)/Grant(s): DAAG55-97-1-0122

Report No.(s): AD-A411143; UILU-ENG-2002-4004; ARO-36425.26-EG; No Copyright; Avail: CASI; A21, Hardcopy

This final report describes the results of a four-year research effort that performed experimental studies in the general area of high speed separated flows. The motivation for this research effort was to investigate in detail high-speed base flows that are similar in nature to those occurring for missiles and projectiles, so that they can be better understood, predicted, and controlled. The research program consisted of two inter-related tasks: (1) planar visualization and measurement of axisymmetric, supersonic base flows; and (2) three-dimensional, supersonic base flows. The research approach consisted of detailed separated flow experiments employing both conventional instrumentation, such as schlieren and shadowgraph photography, surface streakline visualization, and mean and fluctuating pressure measurements, with major emphasis on non-intrusive optical diagnostic techniques, including laser Doppler velocimetry, particle image velocimetry, planar Rayleigh/Mie scattering visualization, planar laser/induced fluorescence, and pressure sensitive paint. We believe that this research effort has contributed significant fundamental understanding of the fluid dynamic mechanisms in separated flows, in addition to the direct relevance of this program to applications of importance to the U.S. Army.

DTIC

High Speed; Separated Flow; Laser Induced Fluorescence; Particle Image Velocimetry; Axisymmetric Flow

20030061393 Naval Postgraduate School, Monterey, CA

Motion Analysis of a Trolley Interface for Ship-to-Ship Cargo Transfer

Higgins, Brian; Dec. 2002; 80 pp.; In English; Original contains color illustrations

Report No.(s): AD-A411323; No Copyright; Avail: CASI; A05, Hardcopy

The goal of this thesis is to investigate the effectiveness of a trolley interface for ship-to-ship cargo transfer. The new interface alleviates some of the torsional problems associated with existing ramp designs and can be effectively utilized for both skin-to-skin and Roll-On Roll-Off operations. A mathematical model is developed in order to predict cargo transfer rates in a seaway. Three dimensional hydrodynamic analysis data are used to calculate expected transfer rates in a seaway between a ship and a discharge facility. Results are presented in standard fully developed Pierson-Moskowitz sea spectra. It is shown that the new design is a viable alternative to existing methods.

DTIC

Mathematical Models; Cargo; Hydrodynamics; Ships

20030061414 NASA Marshall Space Flight Center, Huntsville, AL, USA

Magnetic Control of Solutal Buoyancy Driven Convection

Ramachandran, N.; Leslie, F. W.; [2003]; 1 pp.; In English

Contract(s)/Grant(s): NCC8-66; No Copyright; Avail: Other Sources; Abstract Only

Volumetric forces resulting from local density variations and gravitational acceleration cause buoyancy induced convective motion in melts and solutions. Solutal buoyancy is a result of concentration differences in an otherwise isothermal fluid. If the fluid also exhibits variations in magnetic susceptibility with concentration then convection control by external magnetic fields can be hypothesized. Magnetic control of thermal buoyancy induced convection in ferrofluids (dispersions of ferromagnetic particles in a carrier fluid) and paramagnetic fluids have been demonstrated. Here we show the nature of magnetic control of solutal buoyancy driven convection of a paramagnetic fluid, an aqueous solution of Manganese Chloride hydrate. We predict the critical magnetic field required for balancing gravitational solutal buoyancy driven convection and validate it through a simple experiment. We demonstrate that gravity driven flow can be completely reversed by a magnetic field but the exact cancellation of the flow is not possible. This is because the phenomenon is unstable. The technique can be applied to crystal growth processes in order to reduce convection and to heat exchanger devices for enhancing convection. The method can also be applied to impose a desired g-level in reduced gravity applications.

Author

Buoyancy-Driven Flow; Crystal Growth; Magnetic Control; Buoyancy; Convection

20030061435 Air Force Research Lab., Edwards AFB, CA, USA
Three-Dimensional Simulations of a Gas/Gas, Hydrogen/Oxygen Engine
Archambault, Mark R.; Peroomian, Oshin; Dec. 16, 2002; 20 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410982; AFRL-PR-ED-VG-2002-310; AFRL-PR-ED-VG-2002-310; No Copyright; Avail: CASI; A03, Hardcopy

The objectives include: 1) Develop design tools and methodologies for rocket injectors. 2) Use experimental measurements to develop and anchor state-of-the-art flow codes. 3) Determine level of fidelity required to reasonably reproduce the essential physical behavior of a coaxial gas/gas injector flow.
DTIC
Gas-Gas Interactions; Hydrogen Oxygen Engines; Three Dimensional Models; Computational Fluid Dynamics

35
INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography. For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Avionics and Aircraft Instrumentation*; and *19 Spacecraft Instrumentation and Astrionics*.

20030059493 Lawrence Livermore National Lab., Livermore, CA
Visible Imaging Fourier Transform Spectrometer: Design and Calibration
Wishnow, E. H.; Wurtz, R.; Blasi-Ouellett, S.; Cook, K. H.; Carr, D.; Sep. 19, 2002; 18 pp.; In English
Report No.(s): DE2003-15002522; UCRL-JC-150957; No Copyright; Avail: Department of Energy Information Bridge

We present details of the design, operation and calibration of an astronomical visible-band imaging Fourier transform spectrometer (IFTS). This type of instrument produces a spectrum for every pixel in the field of view where the spectral resolution is flexible. The instrument is a dual-input/dual-output Michelson interferometer coupled to the 3.5 meter telescope at the Apache Point Observatory. Imaging performance and interferograms and spectra from calibration sources and standard stars are discussed.
NTIS
Fourier Transformation; Spectrometers; Visible Spectrum; Calibrating; Design

20030059502 Air Force Research Lab., Rome, NY, USA
Polyphase Filter and Demodulation Techniques for Optimizing Signal Collection Processing
Irizarry, Alfredo V.; Feb. 2003; 44 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): Proj-459E
Report No.(s): AD-A412239; AFRL-IF-RS-TM-2003-3; No Copyright; Avail: CASI; A03, Hardcopy

This document presents the development and implementation of a polyphase filter used for frequency demultiplexing as well as the evaluation of its performance compared to a baseline. A polyphase filter approach is an efficient method that performs frequency demultiplexing by means of decimation, filter reduction and the usage of the FFT algorithm. The development was made using Matlab and C++, The performance was measured in terms of execution speed as function of the filter parameters. The code has been embedded in a GUI that allows the user to go step by step in the design process, i.e., from filter design to audio extraction. The software also implements several demodulation techniques to complement the development.
DTIC
Signal Processing; Filters

20030059532 Smithsonian Institution, Washington, DC, USA
Invention and Development of the Radiosonde, with a Catalog of Upper-Atmospheric Telemetering Probes in the National Museum of American History, Smithsonian Institution
DuBois, J. L.; Multhauf, R. P.; Ziegler, C. A.; 2002; 88 pp.; In English
Report No.(s): PB2003-104317; SMITHSONIAN STUDIES IN HT-53; No Copyright; Avail: CASI; A05, Hardcopy

From a historical perspective, the radiosonde is one of the more significant technological innovation of the twentieth century, not only because its widespread use greatly enhanced the accuracy of weather forecasting, but also because some features of its basic design became the foundation of all modern analog telemetry systems. This study examines the way in

which advances in the technology of non-telemetering balloonsondes and radio in the nineteenth and twentieth centuries culminated in the invention of the radiosonde in 1929. The subsequent development of radiosondes in Europe and the USA from 1929 to 1940 is traced in detail, when the basic design of this instrument achieved its modern form. An overview of significant modifications in radiosonde design after 1940 also is provided because the instruments have remained an essential meteorological tool in the twenty-first century. This monograph also includes a catalog of radiosondes in the Smithsonian Institution's National Museum of American History. Photographs of instruments in this unique collection that graphically depict the development stages of the radiosonde are presented.
NTIS
Radiosondes; Telemetry; Meteorological Instruments; Museums

20030060445 Sheffield Univ., UK
Directional Properties of Surface Waves Observed With HF Radar
Wyatt, Lucy R.; Mar. 17, 2003; 6 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): N00014-99-1-1092
Report No.(s): AD-A412263; No Copyright; Avail: CASI; A02, Hardcopy

The goal of the work at Sheffield is to demonstrate that wave measurements obtained using HF radars are of sufficient accuracy and availability for them to contribute to the investigation of changes to the directional spectrum of waves subject to meteorological bathymetric and current variability in coastal environments for both scientific and operational applications. This report summarizes the measurements made with the OSCR HF radar in collaboration with the University of Miami, during the SHOWEX experiment in fall 1999 using inversion algorithms developed at the University of Sheffield. The data set obtained contains interesting examples of shoaling waves and fetch limited wave development but the amount of data obtained was limited by the hardware constraints of the OSCR system. Comparisons with directional wave buoys confirmed the results of earlier work that signal-to-noise and antenna sidelobes are the main sources of error in the radar wave measurements.
DTIC
Surface Waves; High Frequencies; Directional Control; Radar Imagery

20030060474 Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH
Test Report on Infrared Warning Receiver (IRWR) Flight Vibration Measurements
Banaszak, David; Brown, Dansen; Pearson, Jerome; Apr. 1980; 129 pp.; In English
Contract(s)/Grant(s): Proj-7500
Report No.(s): AD-A412565; AFWAL/FIBG/79-10; No Copyright; Avail: CASI; A07, Hardcopy

This test report presents data which define the vibration environments experienced by two infrared warning receiver (IRWR) units mounted on the HH-53 helicopter and the C-l3OE transport aircraft.
DTIC
Warning Systems; Receivers

20030060477 Massachusetts Inst. of Tech., Lexington, MA
Characterization of Gaseous Effluents in the LWIR From Both Modeling and Hyperspectral Measurements
Griffin, Michael K.; Kerekes, John P.; Farrar, Kristine E.; Burke, Hsiao-hua K.; Feb. 5, 2002; 15 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F19628-00-C-0002
Report No.(s): AD-A412594; No Copyright; Avail: CASI; A03, Hardcopy

Longwave Infrared (LWIR) radiation comprising atmospheric and surface emissions provides information for a number of applications including atmospheric profiling, surface temperature and emissivity estimation, and cloud depiction and characterization, The LWIR spectrum also contains absorption lines for numerous molecular species which can be utilized in quantifying species amounts. Modeling the absorption and emission from gaseous species using various radiative transfer codes such as MODTRAN-4(1) and FASE(2) (a follow-on to the line-by-line radiative transfer code FASCODE(3)) provides insight into the radiative signature of these elements as viewed from an airborne or space-borne platform and provides a basis for analysis of LWIR hyperspectral measurements. In this study, a model platform was developed for the investigation of the passive outgoing radiance from a scene containing an effluent plume layer. The effects of various scene and model parameters including ambient and plume temperatures, plume concentration, as well as the surface temperature and emissivity on the outgoing radiance were estimated. A simple formula relating the various components of the outgoing radiance was used to

study the scale of the component contributions. A number of examples were given depicting the spectral radiance from plumes composed of single or multiple effluent gases as would be observed by typical airborne sensors. The issue of detectability and spectral identification was also discussed.
DTIC
Far Infrared Radiation; Infrared Signatures

20030060556 Johns Hopkins Univ., Laurel, MD, USA
Neutron Production Measurements from Shield Materials
Maurer, R. H.; Kinnison, J. D.; Roth, D. R.; 2002 Microgravity Materials Science Conference; February 2003, pp. 392-396; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A01, Hardcopy

A stack detector system consisting of a silicon transmission detector and a 5mm thick lithium drifted silicon detector was designed and fabricated. This system has the same charged particle anti-coincidence efficiency in the accelerator beam direction as our flight prototype has from a CsI crystal surrounding a thick lithium drifted detector as shown by experiments with 14 MeV neutrons. This system is available for radiation shielding material experiments. From work supported by the National Space Biomedical Research Institute (NSBRI) a de-convolution technique that calculates a most probable incident neutron energy spectrum from the deposited energy spectra measured by the 5mm thick silicon detector was developed and verified. A publication on this result is presently in the review cycle. For fast and high-energy neutrons that four inches (10 cm) of polyethylene is necessary to make a significant reduction in the neutron flux. For the fast (10-20 MeV) neutrons a reduction of a factor of 3 was indicated while for the high-energy neutrons (20-600 MeV) a factor of 4.5 was determined. To study neutrons produced in collisions of high-energy protons with prospective shield materials in the Fall of 2002 are planing. Both the neutron spectra produced in these collisions and the shielding effectiveness of polyethylene for these same spectra will be measured.
Derived from text
Neutrons; Radiation Measurement; Charged Particles; Radiation Shielding; Spectrometers; Portable Equipment

20030060664 Lucent Technologies, Murray Hill, NJ, USA
A Digital Signal Processor for Doppler Radar Sensing of Vital Signs
Lohman, B.; Boric-Lubecke, O.; Lubecke, V. M.; Ong, P. W.; Sondhi, M. M.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A412597; No Copyright; Avail: CASI; A01, Hardcopy

A digital signal processor for Doppler radar sensing of vital signs is described. A voltage waveform signal containing respiration and heartbeat signatures is low-pass filtered (0.7 Hz) for the respiration and band-pass filtered (1.0 - 3.0 Hz) for the heart signal. The autocorrelation function is used to calculate the rate per minute for each of these signals. To make the processor more robust, several signal processing techniques are applied. One of these techniques, a method commonly used on audio signals for formant removal, is called center clipping. Another technique is the use of a Hanning window. To reverse the distinct shape left by the Hanning window an 'undo' window is applied. The processor is programmed in LabVIEW.
DTIC
Doppler Radar; Signal Processing; Digital Systems; Detection; Clinical Medicine

20030060669 NASA Marshall Space Flight Center, Huntsville, AL, USA
Distributed Sensing of Carbon-Epoxy Composites and Filament Wound Pressure Vessels Using Fiber-Bragg Gratings
Grant, J.; Kaul, R.; Taylor, S.; Myer, G.; Jackson, K.; Osei, A.; Sharma, A.; [2003]; 1 pp.; In English; SPIE's Smart Structures and Materials Conference, 2-6 Mar. 2003, San Diego, CA, USA; Copyright; Avail: Other Sources; Abstract Only

Multiple Fiber Bragg-gratings are embedded in carbon-epoxy laminates as well as in composite wound pressure vessel. Structural properties of such composites are investigated. The measurements include stress-strain relation in laminates and Poisson's ratio in several specimens with varying orientation of the optical fiber Bragg-sensor with respect to the carbon fiber in an epoxy matrix. Additionally, fiber Bragg gratings are bonded on the surface of these laminates and cylinders fabricated out of carbon-epoxy composites and multiple points are monitored and compared for strain measurements at several locations.
Author
Epoxy Matrix Composites; Bragg Gratings; Pressure Vessels; Filament Winding; Laminates; Structural Analysis; Strain Measurement

20030061069 NASA Marshall Space Flight Center, Huntsville, AL, USA
Detection of High Energy Cosmic Ray with the Advanced Thin Ionization Calorimeter (ATIC)
Adams, J. H.; Ahn, E. J.; Bashindzhagyan, G.; Case, G.; Chang, J.; Christl, M.; Ellison, S.; Fazely, Ali R.; Ganel, O.; Gould,

R., et al.; [2003]; 1 pp.; In English; Coral Gables Conference, 11-15 Dec. 2002, Fort Lauderdale, FL, USA; No Copyright; Avail: CASI; A01, Hardcopy

ATIC is a balloon-borne investigation of cosmic ray spectra, from below 50 GeV to near 100 TeV total energy, using a fully active Bismuth Gemmate (BGO) calorimeter. It is equipped with the first large area mosaic of small fully depleted silicon detector pixels capable of charge identification in cosmic rays from H to Fe. As a redundancy check for the charge identification and a coarse particle tracking system, three projective layers of x-y scintillator hodoscopes were employed, above, in the center and below a Carbon interaction 'target'. Very high energy gamma-rays and their energy spectrum may provide insight to the flux of extremely high energy neutrinos which will be investigated in detail with several proposed cubic kilometer scale neutrino observatories in the next decade.

Author

Cosmic Rays; Balloon-Borne Instruments; Radiation Measuring Instruments; Energy Spectra; Calorimeters

20030061086 Air Force Inst. of Tech., Wright-Patterson AFB, OH

Effect of Multi-Mode Vibration on Signature Estimation Using A Laser Vibration Sensor

Pepela, Ngoya; Mar. 2003; 92 pp.; In English; Original contains color illustrations

Report No.(s): AD-A412732; AFIT/GE/ENP/03-02; No Copyright; Avail: CASI; A05, Hardcopy

A laser vibration sensor (LVS) can be used to determine the vibrational spectrum of targets such as vehicles using heterodyne laser doppler velocimetry. The vibrational spectra of exterior skin of vehicles are known to have characteristic resonances due to the physical structure driven by motor gears and other moving parts. Each particular class of vehicle has a unique vibrational spectrum. This research shows how a body vibrating in higher order modes has the opportunity to eliminate spectral content of the target's vibrational spectrum while using an LVS to perform spectrum estimation. This is due to roughly equal amounts of laser photons with equal and opposite information about the target's vibrational velocity returning from the body under investigation. This is especially so when observing targets at large distances and the laser spot size has increased to encapsulate higher order modes vibrating at frequencies used for identification purposes. The research also contains preliminary investigations into the mitigation of these effects by use of laser scanning laser pattern intensity changing and advanced signal processing techniques.

DTIC

Signal Processing; Vibrational Spectra; Laser Doppler Velocimeters

20030061208 Universiteit Twente, Enschede, Netherlands

Survival of Adhering Cortical Neurons on Polyethylenimine Micropatterns

Ruardij, T. G.; Goedbloed, M. H.; Rutten, W. L. C.; Oct. 25, 2001; 5 pp.; In English

Report No.(s): AD-A410878; No Copyright; Avail: CASI; A01, Hardcopy

In the neuroscience community there has been a growing interest in the development of neuroelectronic devices that can survive in a physiological surrounding over long periods of time. The development of a cultured neuron probe would be an important step towards improved integration of neural tissue with electronic devices. An essential part of a cultured probe is an efficient contact between electrode and neural tissue for sufficient electrical signal transfer. Therefore, there is a need to improve the neuron-adhesive character of electrodes and avoid neural adhesion around them over longer periods of time. Photolithography facilitates the preparation of chemical patterns of neuron-adhesive substances on microelectrode devices and is a promising tool towards accurate positioning of neurons on top of microelectrodes. The authors are interested in the application of microelectrode arrays (MEAs) for selective stimulation of sprouting axons developed by motor nerves. The final goal is an improved fine control of muscles. In vitro cultured islands of neurons on top of the MEAs are part of a strategy to attract axonal sprouts from nerves onto microelectrodes. The miniaturization of MEAs into cultured probes with acceptable sizes raises questions about the optimal dimensions of the in vitro cultured islands of neurons suitable for long-term adhesion and survival. In this study, the influence of neuron-adhesive pattern geometry on the long-term survival of cortical neural tissue from rat brains was studied over a time period of 15 days. Microwells (depth 0.5 microns) with diameters of 25, 50, 100, and 150 microns and inter-microwell distances of 15, 30, 60, and 90 microns were etched in a neuron-repellent fluorocarbon (FC)-layer and coated with neuron-adhesive polyethylenimine (PEI). Results showed that the survival of neural tissue was geometry-independent after 1, 4, and 8 days but was favored on 150-micron wells after 15 days.

DTIC

Adhesion; Electrodes; Neurons; Cerebral Cortex; Microinstrumentation; Bioinstrumentation; Electron Probes

20030061259 Observatoire de la Cote d'Azur, Caussols, France
Status Report on the Schmidt Telescope CCD Camera Controller
Maury, Alain; Feb. 1994; 78 pp.; In English
Contract(s)/Grant(s): F61708-93-W-0076
Report No.(s): AD-A410889; EOARD-SPC-93-4007; No Copyright; Avail: CASI; A05, Hardcopy

This document describes a new CCD camera controller adapted to Schmidt telescopes. This report contains the following sections: Generalities; Implementation of a multi CCD camera; Controller boards design requirements; Controller design; Electronic components selection; Current status; Test system; Future readout system; Performance of a 9 wide CCD camera in sky surveillance; plus Appendix 1: Schematics of the controller Appendix 2: Data sheets of the all the major components.
DTIC
Schmidt Telescopes; Controllers; CCD Cameras

20030061345 Utah State Univ., Logan, UT, USA
Low Noise Amplification for Optical Detector Arrays
Duncan, A.; Powers, L.; Oct. 25, 2001; 3 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411116; No Copyright; Avail: CASI; A01, Hardcopy

Detection of low intensity light pulses is accomplished using a three stage amplifier design. A highly sensitive input stage provides a large gain and buffers the sensor from the following stages. An integration stage averages the input signal and holds the output value during data collection. Low impedance output drive capability and noise immunity are provided by a third stage. The combination of these three stages produces a system capable of detecting photocurrent signals in the range of 10-100 nA.
DTIC
Low Noise; Amplification; Antenna Arrays; Optical Equipment

20030061349 Department of the Navy, Washington, DC
Multi-Functional Cellular Surface for Underwater Vehicles
McNamara, George C., Inventor; Sandman, Bruce E., Inventor; Myers, Bernard J., Inventor; May 18, 2001; 20 pp.; In English
Patent Info.: Filed 18 May 2001; US-Patent-Appl-SN-9861496
Report No.(s): AD-D020054; No Copyright; Avail: Other Sources

A system of sensors and weapons in the form of individual cells forming a multi-functional cellular skin is provided to cover the outer surface of an underwater vehicle. The cells are engineered to have specific functional capabilities, e.g., acoustic sensing cells, communications cells, munitions cells, control cells and motive cells, and are electromagnetically attached to the vehicle. The functional arrangement of the cells types and the number of layers will be dependent on the desired capabilities and the overall mission of the vehicle. Cells may be deployed from the vehicle individually or in functional groups by decoupling appropriate cells from one vehicle. Once decoupled, motive cells can transport themselves and other cells as necessary, to positions remote from the vehicle. Groups of cells can be deployed to specific locations and arrayed in specific configurations by motive cells, allowing the vehicle to remain in a standoff position.
DTIC
Underwater Vehicles; Patent Applications; Optical Equipment; Surveillance; Skin (Structural Member); Sensors; Embedding

20030061365 Mitre Corp., McLean, VA
Biodetection Architectures
Joyce, Gerald; Feb. 2003; 44 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411190; JSR-02-330; No Copyright; Avail: CASI; A03, Hardcopy

JASON considered the essential components and operation of an effective strategy for homeland biodefense based on technologies that are currently available or likely to become available within the next five years. It is not realistic to undertake a nationwide, blanket deployment of biosensors. This might be done for the detection of airborne anthrax, albeit at substantial cost. However, there are many possible bioterrorism agents and many possible ways in which they can be delivered. Instead, biosensors should be deployed in a focused manner as one component of a broader biodetection architecture that also includes information derived from intelligence gathering and medical surveillance. This information should be analyzed by a team of local experts who are familiar with local vulnerabilities, high-value targets, and environmental conditions. The local analysis team also should be responsible for directing an appropriate response in the event of a bioterrorism attack. They will be guided

by a pre-established 'playbook' that recommends particular responses for a particular set of circumstances, which will have been practiced and refined through staged exercises.
DTIC
Bioinstrumentation; Biological Weapons; Systems Engineering

20030061399 Computer Sciences Corp., Huntsville, AL, USA
Analysis of Near Simultaneous Jimsphere and AMPS High Resolution Wind Profiles
Adelfang, S. I.; January 06, 2003; 1 pp.; In English; 41st Aerospace Sciences Meeting and Exhibit, 6-9 Jan. 2003, Reno, NV, USA
Contract(s)/Grant(s): NAS8-60000; No Copyright; Avail: Other Sources; Abstract Only

The high-resolution wind profile of the Automated Meteorological Profiling System (HRAMPS) is the proposed replacement for the Jimsphere measurement system used to support NASA Shuttle launches from the Eastern Test Range (ETR). Samples of twenty-six ETR near simultaneous Jimsphere and HRAMPS wind profiles were obtained for Shuttle program HRAMPS certification studies. Shuttle systems engineering certification is to ensure that spacecraft and launch vehicle systems performance and safety evaluations for each launch (derived from flight simulations with Jimsphere wind profile data bases) retain their validity when HRAMPS profiles are used on day-of-launch (DOL) in trajectory and loads simulations to support the commit-to-launch decision. This paper describes a statistical analysis of the near simultaneous profiles. In principle the differences between a Jimsphere profile and an HRAMPS profile should be attributed to tracking technology (radar versus GPS tracking of a Jimsphere flight element) and the method for derivation of wind vectors from the raw tracking data. In reality, it is not technically feasible to track the same Jimsphere balloon with the two systems. The aluminized Mylar surface of the standard Jimsphere flight element facilitates radar tracking, but it interferes with HRAMPS during simultaneous tracking. Suspending a radar reflector from an HRAMPS flight element (Jimsphere without aluminized coating) does not produce satisfactory Jimsphere profiles because of intermittent radar returns. Thus, differences between the Jimsphere and HRAMPS profiles are also attributed to differences in the trajectories of separate flight elements. Because of small sample size and a test period limited to one winter season, test measurements during extreme high winds aloft could not have been expected and did not occur. It is during the highest winds that the largest differences between Jimsphere and HRAMPS would occur because the distance between flight elements would be larger. Jimsphere radar tracking noise increases as a function of balloon displacement downrange. The Jimsphere data processing compensates for tracking signal/noise degradation by increasing the smoothing interval. The Jimsphere wind profile effective resolution is a function of downrange distance and altitude, whereas the effective resolution of the HRAMPS should be independent of those variables. The procedure used for editing Jimsphere spikes in Shuttle DOL profiles was not implemented for the Jimsphere profile measurements during the AMPS field tests. For this analysis a code was developed that essentially mimics DOL Jimsphere spike editing. Jimsphere profiles have somewhat more noise in the wavelength range less than 200m defined as the noise floor. No differences between Jimsphere and HRAMPS wind profile pairs have been found that would support denial of HRAMPS certification for application in Shuttle DOL applications. The reliability of the HRAMPS system, which is an important certification issue, is not addressed in this study.
Author
Statistical Analysis; Data Processing; Global Positioning System; Jimsphere Balloons; Launching; Wind Profiles; Signal To Noise Ratios

20030061406 Nanonex Corp., Princeton, NJ, USA
Nanoimprint Lithography of Parallel Patterning of Nanoscale Magnetoelectronic Devices
Kong, Linshu; Koecher, Larry; Dec. 2002; 5 pp.; In English
Contract(s)/Grant(s): N00014-02-M-0115
Report No.(s): AD-A411296; No Copyright; Avail: CASI; A01, Hardcopy

In the last 6 months, Nanonex Corp has developed technologies based on nanoimprint lithography for parallel patterning of nanoscale magnetoelectronic devices.
DTIC
Lithography; Nanotechnology; Electronic Equipment; Microelectronics

20030061412 Naval Postgraduate School, Monterey, CA
Computer-Controlled Photodetector Characterization System (Design and Construction)
Herdlick, Bryan E.; Dec. 2002; 85 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411320; No Copyright; Avail: CASI; A05, Hardcopy

This system was designed to evaluate the response characteristics of photodetectors operating at wavelengths in the 1 micron and 8-12 micron range. A Quartz-Tungsten-Halogen source was used for visible and near-IR energy, and a dedicated IR element provided gray-body radiation with a peak at 1150 Kelvin. A monochromator was employed in conjunction with a six-position filter wheel to provide precise control of energy incident on the photodetectors. Variations in the efficiency of components were compensated for through normalization based on the energy incident on the photo detectors. An intuitive, computer-based interface was developed to automate data collection, and provided numeric and graphic representations of data as it is being collected. At completion, data is exported to a spreadsheet file. A commercial silicon detector was successfully characterized, and accurate voltage response and responsivity curves were generated. A pyroelectric detector was used to verify proper operation of gratings and filters at infrared wavelengths. The system is suitable for its intended purpose, and will be capable of characterizing detectors designed to operate in the 3-5 micron range with the installation of appropriate filters and gratings.
DTIC
Pyroelectricity; Systems Engineering; Photometers; Applications Programs (Computers)

20030061419 Naval Postgraduate School, Monterey, CA
Tracking Control for Autonomous Underwater Vehicles
Keller, Joseph J.; Dec. 2002; 86 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411328; No Copyright; Avail: CASI; A05, Hardcopy

Recovery of Autonomous Underwater Vehicles (AUVs) can often be an autonomous operation itself. In the case of an AUV that is launched and recovered at some significant depth below the surface, the recovery platform to which the vehicle will dock is often not a stationary platform. The recovery cage/platform has dynamics associated with it, which are induced by wave motion effects on the ship to which the cage is tethered. In order to successfully recover a vehicle into a cage platform it will be preferred for the vehicle to have the capability to compensate for this motion when making its final approach to the cage. Using active compensation, a smaller cage can be utilized for recovery of an AUV. This research attempts to investigate a means by which a vehicle may be made to track, in depth, dynamic motion with zero phase lag between the vehicle and the recovery platform utilizing an error space controller.
DTIC
Autonomy; Underwater Vehicles; Controllers; Tracking (Position)

36
LASERS AND MASERS

Includes lasing theory, laser pumping techniques, maser amplifiers, laser materials, and the assessment of laser and maser outputs. For cases where the application of the laser or maser is emphasized see also the specific category where the application is treated. For related information see also *76 Solid-State Physics*.

20030059498 Argonne National Lab., IL, USA
Time-Resolved Measurement of a Self-Amplified Free Electron Laser
Li, Y.; Lewellen, J.; Huang, Z.; Sajaev, V.; Milton, S. V.; 2002; In English
Report No.(s): DE2003-803892; No Copyright; Avail: National Technical Information Service (NTIS)

We report on a time-resolved measurement of self-amplified spontaneous emission (SASE) free-electron laser (FEL) pulses. We observed that the spikes in the output of such free-electron laser pulses have an intrinsic positive chirp and the energy chirp in the electron bunch mapped directly into the FEL output. The measurement also provides rich information on the statistics of the FEL output.
NTIS
Free Electron Lasers; Spontaneous Emission; Pulsed Lasers; Measurement

20030060632 New Mexico Univ., Albuquerque, NM
Ultralow Threshold Semiconductor Lasers Based on Gain without Inversion
Malloy, Kevin; Sep. 1999; 38 pp.; In English
Contract(s)/Grant(s): F49620-96-1-0325; Proj-2305
Report No.(s): AD-A412265; AFRL-SR-AR-TR-03-0074; No Copyright; Avail: CASI; A03, Hardcopy

Quantum interference effects in semiconductors for use in the active regions of low threshold lasers. Quantum interference lies behind electromagnetic induced transparencies and gain without inversion in three level systems. Achieving this behavior

in reduced dimensionality semiconductor quantum systems opens a host of potential applications and devices. Experiments in atomic systems and modeling of semiconductors has established the conditions and configurations necessary for these phenomena. The initial portion of our proposed work expands our theory and modeling and performs experimental investigation of the optical properties of various quantum interference configurations. We plan to add time dependence and many-body effects to our theory and plan to investigate optical and intrinsic coupling configurations experimentally. For low threshold lasing, we will investigate the possibility of excitonic lasing without inversion in semiconductor quantum wells based on the AlGaInAs materials system. Both interband and intraband lasers will be investigated.
DTIC
Semiconductor Lasers; Inversions; Amplification

20030060667 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Cold-Flow Testing of A Subscale Model Exhaust System for a Space-Based Laser
Bautista, Ian S.; Mar. 2003; 108 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412667; AFIT/GAE/ENY/03-1; No Copyright; Avail: CASI; A06, Hardcopy

The purpose of this research was to continue a study of gas-dynamic phenomena that occurred in stacked cylindrical rings of nozzles and an exhaust manifold as reported by Captain Scott Bergren in 2002. The rings and exhaust manifold were part of a 1/5-scale model of one quadrant of the conceptual Space Based Laser Integrated Flight Experiment (SBL IFX) gas dynamic laser. This model was mated to a blow-down/vacuum wind tunnel and consisted of a nozzle array, centerbody, supersonic diffuser, and a transition structure to mate the vacuum and test section. During Capt Bergren's research, supersonic flow was found to only last for 0.2 seconds from wind tunnel startup. The short duration of the supersonic flow was due to the transition structure being too small and not being able to 'swallow' the shock wave. The objectives of this research were to remodel the transition structure and evaluate the test section to see if simulation of the expected fluid flow properties in the conceptual SBL IFX design was possible using cold-flow. The transition structure was remodeled to capture the entire vacuum line entrance area while still mating to the diffuser exit. Using rapid data acquisition and schlieren photography, results indicated that supersonic flow lasted for approximately 10 seconds from startup. During this time, a well-defined oblique shock wave inside the optical cavity attached to the leading edge of the centerbody, where the flow reached a velocity of Mach 2.8.
DTIC
Exhaust Systems; Scale Models; Cold Flow Tests; Gasdynamic Lasers; Spaceborne Lasers

20030060693 Air Force Inst. of Tech., Wright-Patterson AFB, OH
Phasing a Dual Optical Path System Using an Optical Fiber as a Phase Conjugate Mirror
Willis, Shawn M.; Mar. 2003; 74 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412678; AFIT/GAP/ENP/03-06; No Copyright; Avail: CASI; A04, Hardcopy

Phase conjugation properties of stimulated Brillouin scattering (SBS) in a short multimode fiber have been investigated with an eye towards its application for a multi-channel double pass master oscillator power amplifier (MOPA) system. In particular, properties of the SBS beam to compensate for the axial and transverse phase distortion between individual channels in a multi-channel amplifier system were studied. Two optical paths were created by covering half of the laser beam with a microscope slide, and also by spatially splitting the wavefronts with a 4 prism set-up. The Stokes beams that traversed the same optical paths as the pump beams were shown to compensate the phase distortion introduced by the different optical paths.
DTIC
Light Scattering; Laser Beams; Phase Conjugation; Transmission Lines; Fiber Optics

20030061148 NASA Marshall Space Flight Center, Huntsville, AL, USA
Effects of Two-Pulse Sequencing on Characteristics of Elementary Propellants for Ablative Laser Propulsion
Thompson, M. Shane; Pakhomov, Andrew V.; Herren, Kenneth A.; January 2003; 1 pp.; In English; First International Symposium on Beamed Energy Propulsion, 5-7 Nov. 2002, Huntsville, AL, USA; Copyright; Avail: Other Sources; Abstract Only

This work continues on previous investigations of elementary propellants for Ablative Laser Propulsion (ALP). This paper details the experimental methods used for alignment of a non-colinear temporal pulse splitting apparatus. Spatial coincidence of the separate pulses is established, the pulses are delayed, and first data is reported on this pulse spacing effect on time-of-fight (TOF) measurements. This includes ion velocity and number density measurements, and this data is compared

to results from a previous work. Also, first data on the experimental determination of the time required for the laser-induced plasma to become purely reflective to incident pulses is presented.
Author
Laser Propulsion; Propellants; Pulsed Lasers; Laser Ablation

20030061195 Energy Research Consultants, Inc., Laguna Hills, CA, USA
Accounting for Laser Extinction, Signal Attenuation, and Secondary Emission While Performing Optical Patternation in a Single Plane
Brown, C. T.; McDonnell, V. G.; Talley, D. G.; Jan. 10, 2002; 7 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410872; AFRL-PR-ED-TP-2002-008; No Copyright; Avail: CASI; A02, Hardcopy

An optical patternation method is described where the effects of laser extinction and signal attenuation can be corrected for, and where secondary scattering effects are reduced by probing the spray with a swept beam instead of a laser sheet. The use of the swept beam also allows the signals to be detected within the same plane as the sweep, thus eliminating the requirement to perform a tedious 3D mapping in order to correct for signal attenuation effects. Conditions are described in which the method might possibly be applied to non-spherical droplets. Measurements in a fan spray indicate that the method is consistent with PDI measurements.
DTIC
Spatial Distribution; Laser Applications; Spraying; Extinction

37
MECHANICAL ENGINEERING

Includes mechanical devices and equipment; machine elements and processes. For cases where the application of a device or the host vehicle is emphasized see also the specific category where the application or vehicle is treated. For robotics see *63 Cybernetics, Artificial Intelligence, and Robotics*; and *54 Man/System Technology and Life Support*.

20030061124 Aerospace Corp., El Segundo, CA
Failure Analysis of Three Si3N4 Balls Used in Hybrid Bearings
O'Brien, M. J.; Presser, N.; Robinson, E. Y.; Feb. 15, 2003; 29 pp.; In English
Contract(s)/Grant(s): F04701-00-C-0009
Report No.(s): AD-A412842; TR-2003(8565)-1; SMC-TR-03-12; No Copyright; Avail: CASI; A03, Hardcopy

The rolling-element fatigue life of advanced hybrid material bearings consisting of silicon-nitride balls, REX20 tool-steel inner races, and CRU20 tool-steel outer races was measured under well-qualified laboratory testing. Multiple sets of four bearings (207H size) were tested using the least-of-four technique and sudden-death statistics to obtain a Weibull distribution based upon a bivariate model that accounted for load, time, and sample size. The Weibull distribution model shows that the advanced material bearings are projected to have 6.7 times greater life than the reference 52100 steel bearings at 90\% confidence and 12 times greater life at 50\% confidence under the test conditions. A fractographic analysis of three failed ceramic balls was performed. In each instance, the initiation of the final fracture was traced back to a relatively small site. In two cases, interesting features are identified that may represent the potential cause for the failure. These potential causes are identified as small defects that are believed to be sintering voids with diameters of less than 2 micrometers. The balls' very long lives under elevated loading suggest that the manufacturer is controlling the population of pre-existing manufacturing flaws very well.
DTIC
Silicon Nitrides; Ball Bearings; Failure Analysis

20030061190 NASA Marshall Space Flight Center, Huntsville, AL, USA
Self-Reacting Friction Stir Welding for Aluminum Alloy Circumferential Weld Applications
Bjorkman, Gerry; Cantrell, Mark; Carter, Robert; [2003]; 27 pp.; In English; Aeromat 2003, 9-12 Jun. 2003, Dayton, OH, USA
Contract(s)/Grant(s): NAS8-00016; Copyright; Avail: CASI; A03, Hardcopy

Friction stir welding is an innovative weld process that continues to grow in use, in the commercial, defense, and space sectors. It produces high quality and high strength welds in aluminum alloys. The process consists of a rotating weld pin tool that plasticizes material through friction. The plasticized material is welded by applying a high weld forge force through the

weld pin tool against the material during pin tool rotation. The high weld forge force is reacted against an anvil and a stout tool structure. A variation of friction stir welding currently being evaluated is self-reacting friction stir welding. Self-reacting friction stir welding incorporates two opposing shoulders on the crown and root sides of the weld joint. In self-reacting friction stir welding, the weld forge force is reacted against the crown shoulder portion of the weld pin tool by the root shoulder. This eliminates the need for a stout tooling structure to react the high weld forge force required in the typical friction stir weld process. Therefore, the self-reacting feature reduces tooling requirements and, therefore, process implementation costs. This makes the process attractive for aluminum alloy circumferential weld applications. To evaluate the application of self-reacting friction stir welding for aluminum alloy circumferential welding, a feasibility study was performed. The study consisted of performing a fourteen-foot diameter aluminum alloy circumferential demonstration weld using typical fusion weld tooling. To accomplish the demonstration weld, weld and tack weld development were performed and fourteen-foot diameter rings were fabricated. Weld development consisted of weld pin tool selection and the generation of a process map and envelope. Tack weld development evaluated gas tungsten arc welding and friction stir welding for tack welding rings together for circumferential welding. As a result of the study, a successful circumferential demonstration weld was produced leading the way for future circumferential weld implementation.
Author
Friction Stir Welding; Aluminum Alloys; Welded Joints; Welding

20030061239 NASA Marshall Space Flight Center, Huntsville, AL, USA
Rayleigh-Benard Instability in a Vertical Cylinder with a Rotating Magnetic Field
Walker, J. S.; Volz, M. P.; Mazuruk, K.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

This paper presents a linear stability analysis for the Rayleigh-Benard convection in a finite-length, vertical cylinder with a rotating magnetic field. The vertical wall of the cylinder is adiabatic, and planar top and bottom walls are isothermal with a higher temperature at the bottom. The stabilizing effects of the rotating magnetic field are studied for four values of the Prandtl number. Results for one Prandtl number are compared to previously published experimental results.
Author
Magnetic Fields; Rayleigh-Benard Convection; Stability Tests; Cylinders; Linearity; Rotation

38
QUALITY ASSURANCE AND RELIABILITY

Includes approaches to, and methods for reliability analysis and control, quality control, inspection, maintainability, and standardization.

20030060411 Iowa State Univ. of Science and Technology, Ames, IA
Remote Field Eddy Current Probes for the Detection of Stress Corrosion Cracks in Transmission Pipelines
Ivanov, P. A.; 2002; 96 pp.; In English
Report No.(s): DE2003-804540; No Copyright; Avail: Department of Energy Information Bridge

Magnetic flux leakage (MFL) is a technique used widely in non-destructive testing (NDT) of natural gas and petroleum transmission pipelines. This inspection method relies on magnetizing the pipe-wall in axial direction. The MFL inspection tool is equipped with an array of Hall sensors located around the circumference of the pipe, which registers the flux leakage caused by any defects present in the pipe-wall. Currently, the tool magnetizes the pipewall in axial direction making it largely insensitive to axially oriented defects. One type of defect, which is of a growing concern in the gas and petroleum industry is the stress corrosion crack (SCC). The SCCs are a result of aging, corrosion, fatigue and thermal stresses. SCCs are predominantly axially oriented and are extremely tight, which makes them impossible to be detected using current inspection technology. A possible solution to this problem is to utilize the remote field eddy current (RFEC) effect to detect axially oriented defects. The RFEC method has been widely used in industry in the inspection of tubular products. The method uses a pair of excitation and pick-up coils. The pick-up coil located in the remote field region, usually two, three pipe-diameters away from the excitation coil. With RFEC the presence of defects is detected by the disturbance in the phase of the signal measured by the pick-up coil relative to that of the excitation coil. Unlike conventional eddy current testing the RFEC method is sensitive to defects on the exterior of the inspected product, which makes it a good candidate for the development of in-line inspection technology. This work focuses on the development of non-destructive testing technique, which uses remote field eddy currents induced by rotating magnetic field (RMF). A major advantage of the RMF is that it makes possible to not only detect a defect but also localize its position in circumferential direction. Also, it could potentially allow detection of defects, regardless of their shape and orientation. In this work the RFEC-RMF technique is investigated and is shown to be a useful tool in the detection of axially oriented, circumferentially oriented and skewed notches, SCCs and round defects. Finally, a

data acquisition system is designed, capable of performing the RFEC-RMF measurements automatically.
NTIS
Nondestructive Tests; Stress Corrosion Cracking; Pipelines; Eddy Currents

20030060419 National Inst. of Standards and Technology, Gaithersburg, MD
Standard Reference Materials: The First Century
Rasberry, S. D.; Jan. 2003; 40 pp.; In English
Report No.(s): PB2003-103395; NIST/SP-2600-150; No Copyright; Avail: CASI; A03, Hardcopy

Over the course of its first one hundred years, the National Institute of Standards and Technology (NIST) has made numerous contributions to advancing the science and practice of analytical chemistry. Contributions to fundamental constants and reference data, such as determination of the Faraday, Avagadro's number, and atomic masses, began at almost the beginning of this institution when it was formed in 1901. Instrumentation development, improvement, and reproducible methods for their use have also been an important part of the NIST effort. This publication describes what may be the organization's most important and certainly its most unique contribution; namely, certified reference materials. Ultimately these certified reference materials would become known at NIST as standard reference materials (SRMs).
NTIS
Analytical Chemistry; Atomic Weights; Standards

39
STRUCTURAL MECHANICS

Includes structural element design, analysis and testing; dynamic responses of structures; weight analysis; fatigue and other structural properties; and mechanical and thermal stresses in structures. For applications see *05 Aircraft Design, Testing and Performance*; and *18 Spacecraft Design, Testing and Performance*.

20030059824 Technical Research Centre of Finland, Espoo, Finland
Smart Materials and Structures. VTT Research Program 2000-2002
Vessonen, S.; Dec. 04, 2002; In English
Report No.(s): PB2003-104676; VTT-SYMPOSIUM-225; Copyright; Avail: National Technical Information Service (NTIS)

This publication documents the presentations given at the closing seminar of the 'Smart Materials and Structures' technology program on December 4th 2002 at Otaniemi, Espoo. The purpose of the seminar was to summarise and present, to VTTs researchers and invited representatives of industry, the research work and technical results done and achieved in the four subprojects 'Active materials', 'Precision motion and force', 'Active durability control', and 'Active vibration control' of the program.
NTIS
Conferences; Vibration Damping; Smart Materials; Shape Memory Alloys

20030060441 Air Force Research Lab., Edwards AFB, CA, USA
Material Mechanics Research
Liu, C. T.; Feb. 2003; 17 pp.; In English
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A412622; AFRL-PR-ED-TR-2003-0006; No Copyright; Avail: CASI; A03, Hardcopy

This report covers results of research addressing cumulative damage and crack growth behavior in a solid propellant and interfacial fracture of bi-material bonded systems. The program s basic approach involves a blend of analytical and experimental studies. In general, mechanisms and mechanics involved in cohesive fracture in the solid propellant and adhesive fracture in the bi-material bonded systems are emphasized. The results of both analytical and experimental analyses are evaluated and discussed.
DTIC
Crack Propagation; Solid Propellants

20030060682 Air Force Research Lab., Edwards AFB, CA, USA

Investigating Three-Dimensional Effect on Crack Growth Behavior in an Incompressible Material

Liu, C. T.; Smith, C. W.; Feb. 11, 2003; 9 pp.; In English

Contract(s)/Grant(s): Proj-2302

Report No.(s): AD-A410725; AFRL-PR-ED-TP-2003-031; No Copyright; Avail: CASI; A02, Hardcopy

In order to obtain some insight into the three-dimensional effects on the crack growth behavior, a series of experiments on centrally perforated cylinders under internal pressure were conducted using the frozen stress methods. The inner surface of the cylinder has a star shape, which consists of six fins. Part-through cracks were cut at different locations near the fin tip region. The effect of crack location on the crack growth behavior and the role of shear modes during crack turning were investigated and the results are discussed.

DTIC

Crack Propagation; Incompressibility

20030060687 Air Force Research Lab., Edwards AFB, CA, USA

Investigating the Deformation and Failure Mechanisms in Bi-Material Systems Under Tension

Liu, C. T.; Chiang, Fu-Pen; May 22, 2002; 17 pp.; In English; ASME Winter Meeting, 24-28 Jun. 2002, Blacksburg, VA, USA

Contract(s)/Grant(s): Proj-2302

Report No.(s): AD-A410743; AFRL-PR-ED-VG-2002-130; No Copyright; Avail: CASI; A03, Hardcopy

No abstract available

DTIC

Composite Materials; Deformation; Rubber; Failure

20030061077 Arizona State Univ., Tempe, AZ

Experimental Investigation in Vibration Control and Damage Detection of Smart Composites

Chattopadhyay, Aditi; Jul. 12, 2001; 5 pp.; In English

Contract(s)/Grant(s): F49620-00-1-0246; Proj-3484

Report No.(s): AD-A410796; AFRL-SR-AR-TR-03-0018; No Copyright; Avail: CASI; A01, Hardcopy

The Laser Doppler Vibrometer (LDV) optical instrument purchased under the DURIP grant is used for accurately measuring velocity (and displacement) of vibrating surfaces completely without contact. It is a complete, self-contained area vibration measurement and analysis system. The LDV automatically collects complete vibration data from up to thousands of individual points on a user-defined area. An important feature in scanning vibrometers is the ability to validate and improve the quality of measured data at every scan point. This overcomes problems caused by dark speckles and other unavoidable phenomena present in laser vibrometry. The system purchased is also equipped with Live and Fully Integrated Video Imaging. The equipment is particularly useful at higher frequencies (above Skit) where accelerometers become increasingly inaccurate due to their own dynamic characteristics and influences. A large number of applications that require measurements at very high frequencies and cannot be accomplished using accelerometers include piezoelectric transducers and exciters, NDE flaw detection, rotor blades, disk drive components and micro-sensors and actuators.

DTIC

Composite Materials; Vibration Meters; Smart Materials

20030061123 Air Force Research Lab., Wright-Patterson AFB, OH

Characterization of Fretting Fatigue Crack Initiation Processes in CR Ti-6Al-4V

Hutson, A. L.; Neslen, C.; Nicholas, T.; Feb. 2003; 13 pp.; In English

Contract(s)/Grant(s): F33615-98-C-5214; Proj-4347

Report No.(s): AD-A412841; AFRL-ML-WP-TP-2003-415; No Copyright; Avail: CASI; A03, Hardcopy

A study was conducted to quantify fretting fatigue damage and to evaluate the residual fatigue strength of specimens subjected to a range of fretting fatigue test conditions. Flat Ti-6Al-4V specimen were tested against flat Ti-6Al-4V fretting pads with blending radii at the edges of contact. Fretting fatigue damage for two combinations of static average clamping stress and applied axial stress was investigated for two percentages of total life. Accumulated damage was characterized using full field surface roughness evaluation and scanning electron microscopy (SEM). The effect of fretting fatigue on uniaxial fatigue strength was quantified by interrupting fretting fatigue tests: and conducting uniaxial residual fatigue strength tests at

R = 0. 5 at 300 Hz. Results from the residual fatigue strength tests were correlated with characterization results.
DTIC
Crack Propagation; Fretting; Fatigue Tests

20030061177 Spectral Sciences, Inc., Burlington, MA, USA
Simulations of Ground and Space-Based Oxygen Atom Experiments
Finchum, A., Technical Monitor; Cline, J. A.; Minton, T. K.; Braunstein, M.; April 7, 2003; 4 pp.; In English; 9th International Conference on Materials in a Space Environment, 16-20 Jun. 2003, Netherlands
Contract(s)/Grant(s): NAS8-00201; Copyright; Avail: CASI; A01, Hardcopy

A low-earth orbit (LEO) materials erosion scenario and the ground-based experiment designed to simulate it are compared using the direct-simulation Monte Carlo (DSMC) method. The DSMC model provides a detailed description of the interactions between the hyperthermal gas flow and a normally oriented flat plate for each case. We find that while the general characteristics of the LEO exposure are represented in the ground-based experiment, multi-collision effects can potentially alter the impact energy and directionality of the impinging molecules in the ground-based experiment. Multi-collision phenomena also affect downstream flux measurements.
Author
Oxygen Atoms; Space Environment Simulation; Space Weathering; Low Earth Orbits; Computerized Simulation

20030061189 Air Force Research Lab., Edwards AFB, CA, USA
Determination of Crack Growth Rates From Fracture Data in Rubbery Particulate Composites
Miller, T. C.; Apr. 4, 2002; 8 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410881; AFRL-PR-ED-TP-2002-076; No Copyright; Avail: CASI; A02, Hardcopy

Crack growth and growth rates are measured in laboratory conditions to derive their relationship to fracture parameters so the reliability of solid rocket motors can be assessed. The manufacturing method, heterogeneity of the material, and high ductility contribute to difficulties in the measurement and analysis process. Different specimen geometries and methods for measuring crack size have been used and are described, each having unique advantages and disadvantages. The crack sizes, once determined, are usually converted to growth rates with secant methods or polynomial methods. Potential sources of error include accurate boundary condition assessment, subjectivity in crack length measurement, and problems with maintaining proper crack growth in biaxial specimens.
DTIC
Crack Propagation; Solid Rocket Propellants

20030061254 Virginia Univ Charlottesville Center for Risk Management of Engineering Systems, Charlottesville, VA, USA
Multiple-Criteria Decision-Making in the Design of Innovative Lock Walls for Barge Impact; Phase 2, Implementation of Methodologies
Tsang, Joshua L.; Lambert, James H.; Patev, Robert C.; Dec. 2002; 80 pp.; In English
Report No.(s): AD-A410814; ERDC/ITL-TR-02-05; No Copyright; Avail: CASI; A05, Hardcopy

The goal of this research is to develop and implement a methodology for multiple-criteria tradeoff analysis supportive of lock wall design subject to extreme events. The work is the first effort for the U.S. Army Corps of Engineers toward performing tradeoff analysis for lock wall design and considering very rare and severe damages such as barge impacts and earthquakes. In designing lock walls, engineers consider different levels of the extreme events for which to design (e.g., a 50-, 100-, or 500-year return-period event). In the past, lock walls may have been designed for the conservative and extreme scenario. Looking at tradeoffs among design alternatives may reasonably lower costs without sacrificing significant performance. Several criteria or metrics are identified for considering tradeoffs among different designs, including construction cost, the ratio of repair cost to reconstruction cost, repair cost, time to recover, and cost to industry. These metrics reflect the degree of severity of a barge impact or earthquake. In the methodology, three scenarios each of possible barge impacts or earthquakes are selected by a lock wall designer for evaluating the alternatives. By studying the metrics, a decision-maker can see the tradeoffs among different designs. Graphs with the cost of alternative on the vertical axis and the value of a risk metric (e.g., repair cost) on the horizontal axis show the tradeoffs among the alternatives under the extreme event scenarios. A software workbook is developed for the methodology. The implemented methodology is tested using a realistic design

situation, making use of data from actual lock projects. Sensitivity analysis is performed to assess the robustness of the model results.
DTIC
Decision Making; Methodology; Sensitivity Analysis; Mechanical Engineering; Waterways

20030061320 Air Force Research Lab., Edwards AFB, CA, USA
An Investigating of Interfacial Fracture Using Experiments, Modeling, and Simulation
Miller, T. C.; Guan, E.; Todaro, J.; Jun. 11, 2002; 24 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410836; AFRL-PR-ED-TP-2002-100; No Copyright; Avail: CASI; A03, Hardcopy

The high cost and complexity of modern rocket systems provide multiple possibilities for failure, any one of which could result in lost lives and large capital losses. One failure mode involves deterioration of the layered materials near the inside of the rocket motor case. Rocket motor incorporates four layers of materials. Each layer contributes to motor performance in some significant way, but adds complexity and increases the number of potential failure locations. One area that has caused problems is near the liner-propellant interface, which can have defects originating and evolving during the manufacturing, storing, handling, or launching of the rocket. Fracture mechanics of defects near these interfaces is not well understood. Nonlinear material behavior, property gradients, large deformations, and the damage in particulate composites all affect the mechanical behavior.
DTIC
Rocket Linings; Interfaces; Fracture Mechanics

42
GEOSCIENCES (GENERAL)

Includes general research topics related to the Earth sciences, and the specific areas of petrology, mineralogy, and general geology. For other specific topics in geosciences see *categories 42 through 48*.

20030059496 Swedish Defence Research Establishment, Tumba
Design of Rock Tunnels Phase 9
Feb. 2002; In Swedish
Report No.(s): PB2003-103189; FOI-R-0421-SE; No Copyright; Avail: National Technical Information Service (NTIS)

In order to study the propagation of blast wave in tunnel systems, a project started 1995 with tests in full scale and model scale. The full-scale test has been performed in a rock tunnel at the shooting range in Alvdalen. In this phase (9) the effect of different sizes of holes (>sq.Mi2) in a barrier were studied. The objective of this study was to verify that protection for certain equipment can be achieved behind a barrier not completely closed. The pressures were monitored in the whole tunnel system but the emphasis was on the effects behind the barrier. In this phase, only full-scale tests were performed. A charge of 125 or 625 kg of ANFO were detonated at different distances from the barrier. When the hole is 1 sq(m) the pressure starts to build up more slowly behind the barrier.
NTIS
Detonation Waves; Shock Waves

20030060416 Forest Service, Portland, OR
Science Accomplishments of the Pacific Northwest Research Station, 2002
Rapp, V.; 2002; 80 pp.; In English
Report No.(s): PB2003-103378; No Copyright; Avail: CASI; A05, Hardcopy

Citizens of many interests seek to understand forests and their many values. Land managers need know-how as they implement public policy or accomplish private or tribal goals for forests. Policymakers require comprehensive yet readily understandable information on forest-related issues. In 2002, the authors renewed their dedication to their varied customers as they implemented a new strategic plan developed with their help. The authors conduct research to help form basic knowledge. For example this year they found, contrary to popular belief, most summer flow out of the high Cascade Range does not come from annual snowmelt but from groundwater that emerges as springs. The authors' description of this water geology provides context for calculating water budgets and allocation among many important uses. The authors' forest and inventory analysis accelerated in the past several years to provide up-to-date information for all ownerships. In 2002, one

finding, for example, shows that Oregon's land use program appears successful at containing urban expansion within areas zoned for development.
NTIS
Ground Water; Geology; Snow Cover; Land Use; Forests

20030060473 California Univ., Lawrence Berkeley National Lab., Berkeley, CA, USA
Application of Joint Inversion for Mapping Fluid Parameters
Tseng, H. W.; Lee, K. H.; 2002; 6 pp.; In English
Report No.(s): DE2003-807422; No Copyright; Avail: Department of Energy Information Bridge

A two-dimensional joint inversion technique, based on a least-squares criterion of the data misfit and model smoothness, has been developed using electromagnetic (EM) and seismic traveltime data to assess the feasibility of directly inverting for hydrological parameters, such as fluid electrical conductivity, porosity, and saturation. This is accomplished by relating hydrological parameters to geophysical properties with the help of the empirical Archie's law and the Wyllie time average equation. While the latter links the underground seismic wave velocity and subsurface media porosity, the former relates the bulk formation conductivity to hydrological parameters such as fluid conductivity and porosity. Direct joint inversion using various geophysical data also reduces the non-uniqueness of the problem since common parameters are involved, as is the porosity related to both seismic traveltime and magnetic field.
NTIS
Mapping; Seismic Waves; Least Squares Method; Data Correlation; Parameterization

20030060594 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
IGS 2000 Annual Report
2003; In English
Report No.(s): PB2003-105073; No Copyright; Avail: National Technical Information Service (NTIS)

Contents: The IGS Governing Board 2000; Central Bureau Status 2000; Growth of the IGS Network in 2000; Analysis Activities; Data Center Activities 2000; The International Terrestrial Reference Frame; IGS Reference Frame Coordination and Working Group Activities; The IGS/BIPM Time and Frequency Pilot Project; IGS Activities in the Area of the Ionosphere 2000; IGS Tropospheric Products; IGS International GLONASS Service Pilot Project; IGS LEO Pilot Project; Continuous GPS Positioning of Tide Gauges.
NTIS
Global Positioning System; Glonass; Low Earth Orbits

20030061096 NASA Marshall Space Flight Center, Huntsville, AL, USA
Evolution of Local Microstructures of Clusters Undergoing 2-Dimensional Diffusion
Frazier, Donald O.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

A primary objective of our current work is to study the details of evolving microstructures through a study of 'island' formation in heteroepitaxial film/substrate systems. Such systems could be of direct relevance to so-called mixed-dimensional coarsening and to the study of heterostructures grown by thin-film techniques. The spontaneous formation of three-dimensional islands in strained-layer heteroepitaxy, e.g., has emerged as a new technique for the synthesis of self-assembled quantum dots. This work focuses on coarsening by two-dimensional diffusion of three-dimensional droplets on a flat surface.
Author
Microstructure; Epitaxy; Diffusion; Substrates

43
EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth features, phenomena and resources by aircraft, balloon, rocket, and spacecraft; analysis of remote sensing data and imagery; development of remote sensing products; photogrammetry; and aerial photography. For related instrumentation see *35 Instrumentation and Photography*.

20030060629 NASA Marshall Space Flight Center, Huntsville, AL, USA
Evaluating Corn (Zea Mays L.) N Variability Via Remote Sensed Data
Sullivan, D. G.; Shaw, J. N.; Mask, P. L.; Rickman, D.; Luvall, J.; Wersinger, J. M.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Transformations and losses of nitrogen (N) throughout the growing season can be costly. Methods in place to improve N management and facilitate split N applications during the growing season can be time consuming and logistically difficult. Remote sensing (RS) may be a method to rapidly assess temporal changes in crop N status and promote more efficient N management. This study was designed to evaluate the ability of three different RS platforms to predict N variability in corn (Zea mays L.) leaves during vegetative and early reproductive growth stages. Plots (15 x 15m) were established in the Coastal Plain (CP) and Appalachian Plateau (AP) physiographic regions each spring from 2000 to 2002 in a completely randomized design. Treatments consisted of four N rates (0, 56, 112, and 168 kg N ha-1) applied as ammonium nitrate (NH4N03) replicated four time. Spectral measurements were acquired via spectroradiometer (? = 350 - 1050 nm), Airborne Terrestrial Applications Sensor (ATLAS) (? = 400 - 12,500 nm), and the IKONOS satellite (? = 450 - 900 nm). Spectroradiometer data were collected on a biweekly basis from V4 through R1. Due to the nature of - satellite and aircraft acquisitions, these data were acquired per availability. Chlorophyll meter (SPAD) and tissue N were collected as ancillary data along with each RS acquisition. Results showed vegetation indices derived from hand-held spectroradiometer measurements as early as V6-V8 were linearly related to yield and tissue N content. ATLAS data was correlated with tissue N at the AP site during the V6 stage (r2 = 0.66), but no significant relationships were observed at the CP site. No significant relationships were observed between plant N and IKONOS imagery. Using a combination of the greenness vegetation index (GNDVI) and the normalized difference vegetation index (NDVI), RS data acquired via ATLAS and the spectroradiometer could be used to evaluate tissue N variability and estimate corn yield variability under ideal growing conditions.

Author

Corn; Remote Sensing; Variability; Vegetation; Nitrogen

20030060639 NASA Marshall Space Flight Center, Huntsville, AL, USA

Using Remote Sensing Platforms to Estimate Near-Surface Soil Properties

Sullivan, D. G.; Shaw, J. N.; Rickman, D.; Mask, P. L.; Wersinger, J. M.; Luvall, J.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

Evaluation of near-surface soil properties via remote sensing (RS) could facilitate soil survey mapping, erosion prediction, fertilization regimes, and allocation of agrochemicals. The objective of this study was to evaluate the relationship between soil spectral signature and near surface soil properties in conventionally managed row crop systems. High resolution RS data were acquired over bare fields in the Coastal Plain, Appalachian Plateau, and Ridge and Valley provinces of Alabama using the Airborne Terrestrial Applications Sensor (ATLAS) multispectral scanner. Soils ranged from sandy Kandiudults to fine textured Rhodudults. Surface soil samples (0-1 cm) were collected from 163 sampling points for soil water content, soil organic carbon (SOC), particle size distribution (PSD), and citrate dithionite extractable iron (Fed) content. Surface roughness, soil water content, and crusting were also measured at sampling. Results showed RS data acquired from lands with less than 4 % surface soil water content best approximated near-surface soil properties at the Coastal Plain site where loamy sand textured surfaces were predominant. Utilizing a combination of band ratios in stepwise regression, Fed (r2 = 0.61), SOC (r2 = 0.36), sand (r2 = 0.52), and clay (r2 = 0.76) were related to RS data at the Coastal Plain site. In contrast, the more clayey Ridge and Valley soils had r-squares of 0.50, 0.36, 0.17, and 0.57. for Fed, SOC, sand and clay, respectively. Use of estimated eEmissivity did not generally improve estimates of near-surface soil attributes.

Author

Remote Sensing; Soil Mapping; Soil Science; Farm Crops; Agriculture

20030060649 Defence Research and Development Canada, Ottawa, Ontario, Canada

Alert 2002 Ground Truth Missions for Arctic Shoreline Delineation and Feature Extraction

Mattar, Karim E.; Gallop, Lloyd; Lang, Janice; Dec. 2002; 63 pp.; In English; Original contains color illustrations

Report No.(s): AD-A412267; DRDC-TM-2002-147; No Copyright; Avail: CASI; A04, Hardcopy

This technical memo is part of a study to develop and test tools and techniques for improved accuracy, reliability and automation of shoreline delineation and feature extraction, with particular emphasis on the arctic environment. This memo details the RADARSAT imagery and extensive ground truth collected during the spring and summer of 2002 in CFS Alert, Nunavut. The ground truth includes deployment of four radar corner reflectors, measurement of several shorelines and a large variety of other tracks, measurement of a large variety of permanent scatterers and targets of opportunity, extensive photographic record, comparison of the measured and modeled tide at CFS Alert, and plots of the weather during the time period concerned.

DTIC

Arctic Regions; Pattern Recognition; Ground Truth

20030060654 Instituto Nacional de Pesquisas Espacias, Sao Jose dos Campos, Brazil

Report on Phase I of the Geospacial Technologies Project Pertaining to Agricultural Insurance on the Second Corn Crop

AlvesdeMacedo, Mariza; Rudorff, Bernardo Friedrich Theodor; 2002; 136 pp.; In Portuguese; Original contains color illustrations; CD-ROM contains full text document in PDF format

Report No.(s): INPE-9091-RPQ/733; Copyright; Avail: CASI; C01, CD-ROM; A07, Hardcopy

The use of geospatial technologies to monitor and evaluate crop production in ensured crop fields may represent a significant advancement towards a greater participation of private companies in the branch of crop insurance in Brazil. The objective of this work was to evaluate these technologies through the use of both remote sensing satellite images and geographic information system (GIS), in 37 corn fields grown during the winter season of 2001, in the region of Assis, Sao Paulo State. Five images from the Landsat satellite series were acquired at different phenological crop stages. Corn fields were monitored through both visual analysis and temporal trend of the Normalized Difference Vegetation Index (NDVI). Through visual analysis it was possible to distinguish well developed and uniform crop fields from poor developed and lacked crop fields. The last ones are crop fields that have to be field inspected to evaluate the kind and magnitude of damage. The NDVI values confirmed, quantitatively, the visual analysis result indicating that well developed crop fields had much higher NDVI values than poor developed and damaged crop fields. The regression analysis showed that NDVI explained 54\% of observed crop yield variation. Since drought was the major damage factor, a water balance simulation was performed to evaluate crop damage in response to water stress by computing a penalizing factor for corn crop. However, the penalizing factor did not explain the variation in observed crop yield. The use of a navigation GPS (Global Positioning System) together with a Landsat image allowed to obtain, in a quick and precise manner, the limits of the ensured crop fields. The results showed that remote sensing images are fundamental tools to estimate crop damage covered by crop insurance and they should be used to help and optimize the unavoidable field inspection in case of damage.

Author

Corn; Crop Growth; Insurance (Contracts); Geographic Information Systems; Landsat Satellites; Satellite Imagery

20030061146 NASA Marshall Space Flight Center, Huntsville, AL, USA

Rapid Assessment of In Situ Wheat Straw Residue Via Remote Sensing Platforms

Sullivan, D. G.; Shaw, J. N.; Mask, P. L.; Rickman, D.; Luvall, J.; Wersinger, J. M.; Guertal, E. A.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Crop residues influence near surface soil organic carbon content (SOC), impact our ability to remotely assess soil properties, and play a role in global carbon budgets. Methods that measure crop residues are laborious, and largely inappropriate for regional estimates. The objective of this study was to evaluate remote sensing (RS) data for rapid quantification of residue cover. In March 2000 and April 2001, residue plots (15 m x 15 m) were established in the Coastal Plain and Appalachian Plateau physiographic regions of Alabama. Treatments consisted of five wheat (Triticum aestivum L.) straw cover rates (0, 10, 20, 50, and 80\%) replicated 3 times. Soil water content and residue decomposition were monitored. Spectral measurements were acquired via spectroradiometer (350 - 1050 nm), Airborne Terrestrial Applications Sensor (ATLAS) (400 - 12,500 nm), airborne color photography (400 - 600 nm), and IKONOS satellite (450 - 900 nm). Spectroradiometer data were acquired monthly, aircraft images yearly, and satellite per availability. Results showed all platforms successfully estimated residue cover variability using red, near infrared (NIR) and thermal infrared (TIR) regions of the spectrum. Airborne ATLAS imagery was best explaining as much as 98\% of the variability in wheat straw cover. Spectroradiometer, color infrared photography, and IKONOS imagery accounted for 84, 56, and 24\% of the variability, respectively.

Author

Remote Sensing; Soil Science; Wheat; Residues; Farm Crops

20030061370 Universidad de Navarra, Pamploma, Navarra, Spain

Baseline Removal From EMG Recordings

Rodriquez, I.; Gila, L.; Malanda, A.; Campos, C.; Morales, G.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations

Report No.(s): AD-A411204; No Copyright; Avail: CASI; A01, Hardcopy

A method for baseline (BL) removal in needle EMG records is presented. Different processing techniques are sequentially used. Firstly motor unit action potentials (MUAPs) are extracted from the signal by means of a wavelet transform- based procedure. Potential-free, discontinuous segments are thus obtained, whose fluctuation is assumed to be related to BL wander. These signals are then time averaged to attenuate the effect of noise and of low amplitude MUAPs originated distant from the

electrode. Spline interpolation is then used to build a continuous reconstructed signal whose spectral characteristics approximate that of the real BL. The spectrum of this signal is estimated by AR modeling and an FIR filter is implemented accordingly for filtering out the BL low frequency components from the original EMG signal. Two merit figures are devised, which measure the degree of BL fluctuation present in an EMG record. These figures are used to compare our method with the conventional approach which consider the BL to be a constant value. Experiments for BL removal from real and simulated EMG signals are carried out. The superior performance of our approach is shown regarding these merit figures and visual inspection.
DTIC
Electromyography; Computerized Simulation; Visual Observation; Signals

20030061411 NASA Marshall Space Flight Center, Huntsville, AL, USA
Fractals and Spatial Methods for Mining Remote Sensing Imagery
Lam, Nina; Emerson, Charles; Quattrochi, Dale; [2003]; 2 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

The rapid increase in digital remote sensing and GIS data raises a critical problem -- how can such an enormous amount of data be handled and analyzed so that useful information can be derived quickly? Efficient handling and analysis of large spatial data sets is central to environmental research, particularly in global change studies that employ time series. Advances in large-scale environmental monitoring and modeling require not only high-quality data, but also reliable tools to analyze the various types of data. A major difficulty facing geographers and environmental scientists in environmental assessment and monitoring is that spatial analytical tools are not easily accessible. Although many spatial techniques have been described recently in the literature, they are typically presented in an analytical form and are difficult to transform to a numerical algorithm. Moreover, these spatial techniques are not necessarily designed for remote sensing and GIS applications, and research must be conducted to examine their applicability and effectiveness in different types of environmental applications. This poses a chicken-and-egg problem: on one hand we need more research to examine the usability of the newer techniques and tools, yet on the other hand, this type of research is difficult to conduct if the tools to be explored are not accessible. Another problem that is fundamental to environmental research are issues related to spatial scale. The scale issue is especially acute in the context of global change studies because of the need to integrate remote-sensing and other spatial data that are collected at different scales and resolutions. Extrapolation of results across broad spatial scales remains the most difficult problem in global environmental research. There is a need for basic characterization of the effects of scale on image data, and the techniques used to measure these effects must be developed and implemented to allow for a multiple scale assessment of the data before any useful process-oriented modeling involving scale-dependent data can be conducted. Through the support of research grants from NASA, we have developed a software module called ICAMS (Image Characterization And Modeling System) to address the need to develop innovative spatial techniques and make them available to the broader scientific communities. ICAMS provides new spatial techniques, such as fractal analysis, geostatistical functions, and multiscale analysis that are not easily available in commercial GIS/image processing software. By bundling newer spatial methods in a user-friendly software module, researchers can begin to test and experiment with the new spatial analysis methods and they can gauge scale effects using a variety of remote sensing imagery. In the following, we describe briefly the development of ICAMS and present application examples.
Author
Remote Sensing; Image Processing; Time Series Analysis; Data; Environmental Monitoring; Scale Effect

44
ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; and solar, geothermal, windpower, and waterwave conversion systems; energy storage; and traditional power generators. For technologies related to nuclear energy production see *73 Nuclear Physics*. For related information see also *07 Aircraft Propulsion and Power; 20 Spacecraft Propulsion and Power*, and *28 Propellants and Fuels*.

20030060405 Department of Energy, Washington, DC
National Hydrogen Energy Roadmap: Production, Delivery, Storage, Conversion, Applications, Public Education and Outreach
Nov. 2002; 62 pp.; In English
Report No.(s): PB2003-104939; No Copyright; Avail: CASI; A04, Hardcopy

Hydrogen holds the potential to provide a clean, reliable, and affordable energy supply that can enhance Americas economy, environment, and security. This Roadmap provides a blueprint for the coordinated, long-term, public and private

efforts required for hydrogen energy development. In the coming decades, the USA will need new energy supplies and an upgraded energy infrastructure to meet growing demands for electric power and transportation fuels. Hydrogen provides high efficiency, can be produced from a variety of domestically available resources, and offers near-zero emissions of pollutants and greenhouse gases. Developing hydrogen as a major energy carrier, however, will require solutions to many challenges in the areas of infrastructure, technology, and economics. The U.S. Department of Energy initiated a National Hydrogen Vision and Roadmap process in response to recommendations in the National Energy Policy. The first step in that process resulted in publication of the National Vision of Americas Transition to a Hydrogen Economy (February 2002). This Roadmap represents the next step in that process.
NTIS
Clean Energy; Hydrogen Production; Transportation; Clean Fuels; Energy Conversion

20030060651 Naval Research Lab., Washington, DC
Silicon Etching in LAPPS
Leonhardt, D.; Walton, S. G.; Blackwell, D. D.; Fernsler, R. F.; Meger, R. A.; Mar. 14, 2003; 32 pp.; In English
Report No.(s): AD-A412285; NRL/MR/6750--03-8665; No Copyright; Avail: CASI; A03, Hardcopy

Initial tests using LAPPS to etch silicon with sulfur hexafluoride-containing plasmas were carried out. Material removal rates and anisotropy were determined with respect to gas composition and substrate RF-induced self-bias level. At room temperature, the removal rate increased linearly with substrate bias. Mixtures of argon and sulfur hexalluoride etched approximately ten times faster (5000 A/min) than similar mixtures of oxygenisulfur hexalluoride (^500 A/ min), with the difference being attributed to the passivation of the silicon by involatile silicon oxyfluoride (SiO(x)F(y),) compounds. At low-incident ion energies, these involatile species are believed to cause the observed tapered feature profiles, which became more vertical with increasing ion energy. Plasma and surface chemistry are also discussed, including the negative ion character of these plasmas.
DTIC
Etching; Electron Beams; Silicon; Plasmas (Physics)

20030061258 Air Force Research Lab., Edwards AFB, CA, USA
Digital Signal Processing Techniques for Positioning of Off-Axis Solar Concentrators
Beasley, Joseph N.; Oct. 23, 2002; 9 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A410937; AFRL-PR-ED-TP-2002-249; No Copyright; Avail: CASI; A02, Hardcopy

This paper will discuss the results of using digital signal processing (DSP) techniques to determine the location of the focal point of an off-axis solar concentrator projected onto a visually complex thruster absorber and secondary concentrator. Once the location of the focal spot is located, position control information is generated to move the concentrator to a location that maximizes power transfer. A program that simulates an off-axis solar concentrator is used to generate binary 'image' files to analyze for positioning information. The analysis progresses from Discrete Fourier analysis on the two-dimensional images, through spectrograms, to introduce wavelets and wavelet analysis to verify conceptually using DSP techniques to determine position information.
DTIC
Concentrators; Digital Techniques; Positioning; Signal Processing; Solar Collectors

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ENVIRONMENT POLLUTION

Includes atmospheric, water, soil, noise, and thermal pollution.

20030060401 California Univ., Riverside, CA, USA, Unisearch Associates, Inc., Concord, Ontario, Canada
Effect of Fuel Sulfur on NH3 and Other Emissions from 2000-2001 Model Year Vehicles
Durbin, T. D.; Miller, J. W.; Pisano, J. T.; Sauer, C. G.; Rhee, S. H.; May 2003; 122 pp.; In English
Report No.(s): PB2003-104518; CRC-E-60; No Copyright; Avail: CASI; A06, Hardcopy

The reduction of fuel sulfur levels in gasoline is considered to be an important factor in attaining present and future vehicle emissions standards and air quality goals. Numerous studies have shown that sulfur reduces the efficiency of the catalytic converter and increases regulated emissions. Although catalysts reduce most emissions, some pollutants, such as ammonia, can be formed over the catalyst surface. Since ammmonia is primarily formed on the catalyst surface, it has been

suggested that sulfur could inhibit ammmonia formation on the catalyst by inhibiting reaction sites for ammmonia formation, leading to increases in ammonia emissions as fuel sulfur levels are decreased.
NTIS
Diesel Fuels; Sulfur; Ammonia; Exhaust Emission; Air Pollution; Pollution Control

20030061226 NASA Marshall Space Flight Center, Huntsville, AL, USA
Boundary Layer Aerosol Composition over Sierra Nevada Mountains using 9.11- and 10.59-micron CW Lidars and Modeled Backscatter from Size Distribution Data
Cutten, D. R.; Jarzembski, M. A.; Srivastava, V.; Pueschel, R. F.; Howard, S. D.; McCaul, E. W., Jr.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

An inversion technique has been developed to determine volume fractions of an atmospheric aerosol composed primarily of ammonium sulfate and ammonium nitrate and water combined with fixed concentration of elemental and organic carbon. It is based on measured aerosol backscatter obtained with 9.11 - and 10.59-micron wavelength continuous wave CO2 lidars and modeled backscatter from aerosol size distribution data. The technique is demonstrated during a flight of the NASA DC-8 aircraft over the Sierra Nevada Mountain Range, California on 19 September, 1995. Volume fraction of each component and effective complex refractive index of the composite particle were determined assuming an internally mixed composite aerosol model. The volume fractions were also used to re-compute aerosol backscatter, providing good agreement with the lidar-measured data. The robustness of the technique for determining volume fractions was extended with a comparison of calculated 2.1,-micron backscatter from size distribution data with the measured lidar data converted to 2.1,-micron backscatter using an earlier derived algorithm, verifying the algorithm as well as the backscatter calculations.
Author
Atmospheric Boundary Layer; Atmospheric Composition; Aerosols; Backscattering; Optical Radar; Particle Size Distribution; Atmospheric Models

20030061287 Defence Science and Technology Organisation, Fishermans Bend, Australia
Using the Hazard Prediction and Assessment Capability (HPAC) Hazard Assessment Program for Radiological Scenarios Relevant to the Australian Defence Force
Hill, Alexander; March 2003; 27 pp.; In English
Report No.(s): DSTO-CR-0294; DODA-AR-012-736; Copyright; Avail: Other Sources

Atmospheric hazard modelling programs are used to predict the dispersion and resultant effects from the release of clouds of toxic materials. Both the Hazard Prediction and Assessment Capability (HPAC) and HOTSPOT are models that can be used to estimate hazards arising from the release of radiological material. A comparison of the two models is undertaken, with strengths and limitations of each model discussed. A recommendation is made that the ADF employ HPAC to model radiological hazards.
Author
Atmospheric Models; Radioactive Materials; Toxic Hazards; Computer Programs; Predictions

20030061375 Naval Health Research Center Wright-Patterson AFB OH, Wright-Patterson AFB, OH, USA
Risk Report on Perfluorooctanesulfonate (PFOS) as a Component of Mist Suppressants in Chrome-Plating Tanks
Bobb, Andrew J.; Still, Kenneth R.; Feb. 2003; 12 pp.; In English
Report No.(s): AD-A411191; TOXDET-03-05; No Copyright; Avail: CASI; A03, Hardcopy

Perfluorooctanesulfonate (PFOS) is a synthetic perfluorinated surfactant recently discovered to be ubiquitous in the environment. Animal data suggest a high tolerance for PFOS, as does epidemiological analysis of workers in PFOS manufacturing plants. A suggested reference dose of 0.02 mg$kg/day is presented. This constitutes an unlikely exposure level in the application of interest, as a component of mist suppressant in chromium plating tanks.
DTIC
Chromium; Plating; Tanks (Containers); Dosage; Risk; Surfactants

46
GEOPHYSICS

Includes Earth structure and dynamics, aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism. For related information see *47 Meteorology and Climatology*; and *93 Space Radiation*.

20030059521 NASA Marshall Space Flight Center, Huntsville, AL, USA
IMAGE EUV Observation of a Radially, Bifurcated Plasmapause: First Observations of a Possible Standing ULF Waveform in the Inner Magnetosphere
Adrian, M. L.; Gallagher, D. L.; Avanov, L. A.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

We present EUV observations of the plasmasphere-plasmapause from 19:38-22:11 UT on 28 June 2000 characterized by the presence of bifurcated radial enhancements of the He(+) plasma distribution in the nighside sector. These features remain stable throughout the period of observation and are found to co-rotate at 67\% of the expected rate. Two-dimensional simulation of the plasmasphere assuming the presence of field lines resonances at L = 1.8 and 2.5 suggest that the organization of the outer plasmasphere and plasmapause is the result convective motion driven by a standing ULF-wave. Preliminary analysis of ground-based magnetometer data provided by the IMAGE magnetometer network during the period of EUV observation indicates the presence of a discrete spectrum of field line resonances extending down to 0.68-mHz.
Author
Extreme Ultraviolet Radiation; Inner Radiation Belt; Plasmapause; Waveforms; Earth Magnetosphere; Image Satellite; Radial Distribution

20030060404 NASA Goddard Space Flight Center, Greenbelt, MD, USA
The LWS Geospace Storm Investigations Exploring the Extremes of Space Weather
September 2002; 129 pp.; In English; Original contains color illustrations
Report No.(s): NASA/TM-2002-211613; Rept-2002-03452-0; NAS 1.15:211613; No Copyright; Avail: CASI; A07, Hardcopy

The Geospace mission of the Living With a Star program is a family of investigations focusing on the compelling science questions that advance our ability to specify, understand, and predict the societal impact of solar variance. Two key areas have been identified as combining both importance to society and potential for scientific progress: 1) characterization and understanding of the acceleration, global distribution, and variability of energetic electrons and ions in the inner magnetosphere, and 2) characterization and understanding of the ionosphere and irregularities that affect communications, navigation and radar systems. Under these broad categories specific science questions have emerged as the priority science objectives for the first Geospace Investigations: How and why do relativistic electrons in the outer zone and slot region vary during geomagnetic storms? How does the long- and short-term variability of the Sun affect the global-scale behavior of the ionospheric electron density and irregularities, especially during magnetic storms and at mid-latitudes? The first Geospace mission will attempt to answer these questions.
Author
Space Weather; NASA Space Programs; Radiation Belts; Solar Activity; Magnetic Storms; Geophysics

20030060586 Texas Univ., Dallas, TX, USA
Advanced Arc-Discharge Carbon Nanotube Growth in Simulated Microgravity: Effects of Geometry and Rotations
Zakhidov, Anvar; Borawski, Phil; Izard, Nicolas; MacKnight, Al; Baughman, Ray; 2002 Microgravity Materials Science Conference; February 2003, pp. 707; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

The objective of this study is to design, fabricate, and evaluate an arc-discharge set-up that simulates microgravity conditions and exploits the advantages of microgravity for the improved growth of single wall carbon nanotubes (SWCNT). These expected advantages are: (1) the growth of longer tubes with fewer defects and (2) an increased output and efficiency of SWCNT production. Another goal is to achieve selective separation of metallic nanotubes from semiconducting ones. A major task was solved in the project: the construction of an arc-discharge chamber in which the geometry of the electrodes and the gas flows create conditions simulating microgravity. Contrary to conventional arc-discharge methods, which use two horizontal electrodes, our chamber utilized a large rotating electrode in center surrounded by electrodes from the top, bottom, and sides - thus simulating all possible directions of the gravitational field. The electrode was rotated to obtain a torroidal distribution of plasma. We discovered major differences in the product from these electrode symmetries. The convective flow of plasma and thermal conditions are quite different between horizontal and vertical electrode configurations. In the g-optimized case where the cathode was above the anode, there was a huge 'mushroom' shaped deposit on the cathode rod containing 80\% SWCNT's. Deposits in the cathode contained graphitic carbon and multi-walled nanotubes. Long 'webs'

containing 40-50\% SWCNT s formed on the upper walls of the chamber. Low density webs containing 30-40\% SWCNT s were found on the bottom of the chamber. The upper part of the cathode rod was covered by a film-type felt contained 50 % SWCNs. Synthesis of other materials such as N and B and the use of composite catalysts are also in progress. Nanotubes synthesized by our methods have been used for the initial studies of the photo-acoustic effect upon illumination by light pulses from a Xenon flash lamp. Mass loss as a function of photon flux was measured. We accidentally found that the nanotubes are ignited by a flash of above approximately 3.50 mw/sq cm, and completely burn away in air. This phenomenon is now being studied in detail.
Author
Carbon Nanotubes; Electrodes; Rotation; Convective Flow

20030060626 NASA Marshall Space Flight Center, Huntsville, AL, USA
Z-mode Sounding Within Propagation 'Cavities' and other Inner Magnetospheric Regions by the RPI Instrument on the IMAGE Satellite
Carpenter, D. L.; Bell, T. F.; Inan, U. S.; Benson, R. F.; Reinisch, B. W.; Gallagher, D. L.; Journal of Geophysical Research; [2003]; ISSN 0148-0227, pp. 1-21; In English; Copyright; Avail: Other Sources

When the Radio Plasma Imager (RPI) on the IMAGE satellite operates in the inner plasmasphere and at moderate to low altitudes over the poles, regions in which the ratio of the local electron plasma frequency f(sub pe) to the local electron gyrofrequency- f(sub ce) may exceed or be less than unity, pulses emitted at the low end of the RPI 3 kHz to 3 MHz sounding frequency range can propagate in the the Z mode as well as the whistler mode. At medium altitudes within the plasmasphere, discrete echoes with turning points Earthward of IMAGE are often observed, analogous to the regular and oblique Z-mode echoes found on topside sounder records. In the polar regions, where f(sub pe) is less than f(sub ce) usually obtains, the echoes tend to be diffuse and to exhibit properties such as an intensity decrease at the local value of f(sub ce), where there is a significant topological change in the Z-mode refractive index surface. At low altitudes near the plasmasphere and in the polar region, passive recordings usually fail to provide clear identification of local plasma parameters, while Z-mode soundings can regularly do so. Within the transition region from the auroral zone to the plasmasphere and the plasmasphere itself, at altitudes from approx. 2000 km upward, we find evidence of the Z-mode cavity phenomenon that has been noted previously in connection with natural wave emissions detected at polar latitudes. Within a Z-mode cavity, discrete Z-mode echoes can be trapped as they propagate along field-aligned paths beween upper-and lower-altitude reflection points. The echoes present unique forms, depending upon whether IMAGE is located above or below a minimum in the altitude profile of the Z-mode cutoff frequency. Through an inversion process, such echoes make possible remote determination of the field-line electron density profile in regions where that profile is poorly known. In two examples, the electron density distribution along the field lines was determined to distances of thousands of km above the location of IMAGE, all on the basis of echo delay information within frequency bands only approx. 30 kHz wide.
Author
Sounding; Earth Magnetosphere; Plasmasphere; Magnetic Poles; Plasma Frequencies; Gyrofrequency; Whistlers

20030060627 Geophysical Observatory, Sodankyla, Finland
Magnetic Results: Sodankyla 2002
Kultima, Johannes, Editor; 2003; ISSN 1456-3673; 41 pp.; In English
Report No.(s): Rept-94; No Copyright; Avail: Other Sources

The Sodankyla Geophysical Observatory was established in 1913; 1914 was the first year of magnetic recordings. The observatory is situated on the east bank of the river Kitinen, ca. 5 km south of Sodankyla village. Until 31.07.1997 it belonged to the Finnish Academy of Science and Letters. Since 01.08.1997 it has been the independent, nation-wide observatory of the University of Oulu.
Derived from text
Geophysical Observatories; Geomagnetism

20030061093 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Comparison of the Refractive Index Structure Constant Derived from Numerical Weather Prediction (NWP) Models and Thermosonde Data
Narcisse, Leon C.; Mar. 2003; 185 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412740; AFIT/GM/ENP/03-04; No Copyright; Avail: CASI; A09, Hardcopy

An accurate depiction of atmospheric turbulence is required for successful employment of a viable airborne laser for the

Department of Defense (DOD). The ABL Special Program Office (SEC) which is tasked by the Missile Defense Agency (MDA) bas not designated any particular numerical weather model that is tasked exclusively to model optical turbulence This research compares CLEAR1, 2 X CLEAR I and thermosonde derived values of the refractive index structure constant to optical turbulence values derived from several numerical weather prediction models currently in use by the DOD. The models used were the fifth Generation Mesoscale Model (MM5), the Coupled Ocean Atmosphere Prediction System (COAMPS) and the Advanced Climate Modeling and Environmental Simulation (ACMES) program Comparisons are presented using thermosonde data collected at Vandenberg AEB california during the period l9-26 Oct 200l Universal Time Coordinated (UTC) results indicate that the model-derived optical turbulence and the thermosonde derived optical turbulence values are statistically different in many cases
DTIC
Numerical Analysis; Atmospheric Circulation

20030061152 NASA Marshall Space Flight Center, Huntsville, AL, USA
Empirical Models of the Plasma Density in the Inner Magnetosphere
Huang, X.; Reinisch, B. W.; Song, P.; Nsumei, P.; Green, J. L.; Gallagher, D. L.; [2003]; 1 pp.; In English; Advances for Space Research, 10-19 Oct. 2002, Houston, TX, USA; Copyright; Avail: CASI; A01, Hardcopy

The radio plasma imager (RPI) on the IMAGE satellite performs radio sounding in the magnetosphere, transmitting coded signals stepping through the frequency range of interest and receiving the returned echoes. The measurements provide the echo amplitude as a function of frequency and echo delay time on a so-called plasmagram. A newly developed algorithm inverts THE echo traces on a plasmagram to electron density spatial distributions. Rased on these observed density distributions, an empirical model is constructed to describe the two-dimensional density distribution in the inner magnetosphere.
Author
Inner Radiation Belt; Plasma Density; Plasmas (Physics); Mathematical Models

47
METEOROLOGY AND CLIMATOLOGY

Includes weather observation forecasting and modification.

20030059516 Lawrence Livermore National Lab., Livermore, CA
Simulations of Aerosol Indirect Effect for IPCC Emissions Scenarios
Chuang, C. C.; Penner, J. E.; Zhang, Y.; Oct. 07, 1999; In English
Report No.(s): DE2003-791412; UCRL-JC-135993; No Copyright; Avail: National Technical Information Service (NTIS)

It has been estimated that the present-day global anthropogenic emissions contribute more than half of the particle mass in sub-micrometer size primarily due to sulfate and carbonaceous aerosol components derived from fossil fuel combustion and biomass burning (IPCC, 1996). These anthropogenic aerosols modify the microphysical properties of clouds by serving as cloud condensation nuclei and enhance the reflectivity of low-level water clouds, leading to a cooling effect on climate variation (primary indirect effect). In this paper, we used a fully coupled climate/chemistry model to estimate the present and future projections of aerosol forcing associated with the primary indirect effect. Simulations were based on the newly developed IPCC anthropogenic emissions for the time period 2000 to 2100. We will present variations of solar radiation flux at the top of the atmosphere for each model scenario to address issues on aerosol/cloud/climate interactions.
NTIS
Aerosols; Atmospheric General Circulation Models; Solar Flux; Emission

20030060415 ENSCO, Inc., Cocoa Beach, FL, USA
Extended Statistical Short-Range Guidance for Peak Wind Speed Analyses at the Shuttle Landing Facility: Phase II Results
Lambert, Winifred C.; June 2003; 27 pp.; In English
Contract(s)/Grant(s): NAS10-01052
Report No.(s): NASA/CR-2003-211188; NAS 1.26:211188; Rept-03-002; No Copyright; Avail: CASI; A03, Hardcopy

This report describes the results from Phase II of the AMU's Short-Range Statistical Forecasting task for peak winds at the Shuttle Landing Facility (SLF). The peak wind speeds are an important forecast element for the Space Shuttle and Expendable Launch Vehicle programs. The 45th Weather Squadron and the Spaceflight Meteorology Group indicate that peak winds are challenging to forecast. The Applied Meteorology Unit was tasked to develop tools that aid in short-range forecasts

of peak winds at tower sites of operational interest. A seven year record of wind tower data was used in the analysis. Hourly and directional climatologies by tower and month were developed to determine the seasonal behavior of the average and peak winds. Probability density functions (PDF) of peak wind speed were calculated to determine the distribution of peak speed with average speed. These provide forecasters with a means of determining the probability of meeting or exceeding a certain peak wind given an observed or forecast average speed. A PC-based Graphical User Interface (GUI) tool was created to display the data quickly.
Author
Wind Velocity; Space Shuttles; Spacecraft Launching; Weather Forecasting

20030060481 National Centers for Environmental Prediction, Silver Spring, MD
Guide to F-Scale Damage Assessment
Apr. 2003; In English
Report No.(s): PB2003-105077; No Copyright; Avail: National Technical Information Service (NTIS)
Recent tornado events have highlighted the need for a definitive F-scale assessment guide to assist our field personnel in conducting reliable post-storm damage assessments and determine the magnitude of extreme wind events. This guide has been prepared as a contribution to our ongoing effort to improve our personnel's training in post-storm damage assessment techniques.
NTIS
Tornadoes; Fujita Method; Structural Analysis; Damage Assessment; Storm Damage

20030060482 National Climatic Data Center, Asheville, NC, USA
Climatology of Recent Extreme Weather and Climate Events
Ross, T.; Lott, N.; Oct. 2000; In English
Report No.(s): PB2003-105093; NCDC-TR-2000-02; No Copyright; Avail: National Technical Information Service (NTIS)
The National Climatic Data Center (NCDC) is responsible for monitoring and assessing the Earth's climate. Each month NCDC provides comprehensive analyses of global and U.S. temperature and precipitation to place the current state of the climate into historical perspective. Identification and assessment of extreme weather events is included as part of this effort. An 'Extreme Weather and Climate Events' suite of web pages highlights these events and provides access to images, descriptions, statistics, and other detailed information for each event via the worldwide web. One of our more popular web pages in the 'Extreme Weather and Climate Events' suite is the 'Billion Dollar U.S. Weather Disaster' page, which focuses on extreme events that caused more than $1 billion in monetary losses in the USA, and provides links to detailed reports on many of these events. During the past twenty years (1980- 1999), 46 'billion-dollar' weather disasters occurred in the U.S. This report provides an overview of these disasters and the damage and loss of life they caused.
NTIS
Weather; Climate Change; Internet Resources

20030060489 Army Research Lab., White Sands Missile Range, NM, USA
Glossary and Catalog of MeT Data Representation
Measure, Edward; Feb. 2003; 13 pp.; In English
Report No.(s): AD-A411989; ARL-TR-2712; No Copyright; Avail: CASI; A03, Hardcopy
The present short report is intended to catalog the major digital formats in wide use for representing meteorological data. Each data format discussed is briefly defined, and references are given to more detailed discussions of the format. The author intends to follow this report with another that discusses the most important formats used for satellite data in considerably greater detail. No claim is made that the list of formats given is exhaustive, and the author would appreciate readers calling his attention to important formats that have been neglected or overlooked for incorporation into future editions. He can be contacted at emeasurearl.army.mil.
DTIC
Data Processing; Meteorology; Atmospheric Physics; Catalogs (Publications)

20030061130 Air Force Inst. of Tech., Wright-Patterson AFB, OH
Data Mining Atmospheric/Oceanic Parameters in the Design of a Long-Range Nephelometric Forecast Tool
Benz, Richard F.; Mar. 2003; 100 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412870; AFIT/GM/ENP/03-02; No Copyright; Avail: CASI; A05, Hardcopy

The Department of Defense calls for long-range forecasts to aid in the planning of operations. The goal of this research was to explore the feasibility of predicting, one month in advance, the total monthly cloud cover over the country of Afghanistan. In an attempt to reach this goal, the following objectives were achieved: (1) climatological synoptic study of Afghanistan; (2) survey of Real Time Nephanalysis, outgoing longwave radiation (OLR), and surface observational data; (3) examination of teleconnection indices and sea surface temperatures; (4) standard statistical analysis for prediction; and (5) classification tree analysis (CART), In addition, due to current world events, CART analysis was also applied over the country of Iraq (see Appendix C). Data were examined using standard statistical regression techniques, including linear and multiple linear regression, and then CART analysis was used for exploring possible concealed predictive structures. Standard statistics showed a strong negative correlation between monthly average OLR and surface observational total cloud cover from the fall through spring months. However, linear regression revealed very weak relationships between the predictor and predictand variables. As well, CART results contained misclassification rates that exceeded established thresholds for operational use. Further studies using CART for atmospheric science applications should be pursued.
DTIC
Forecasting; Cloud Cover; Afghanistan

20030061356 NASA Marshall Space Flight Center, Huntsville, AL, USA
A Total Lightning Climatology for the Tennessee Valley Region
McCaul, E. W.; Goodman, S. J.; Buechler, D. E.; Blakeslee, R.; Christian, H.; Boccippio, D.; Koshak, W.; Bailey, J.; Hallm, J.; Bateman, M., et al.; [2003]; 1 pp.; In English; 12th International Conference on Atmosphere Electricity, 9-14 Jun. 2003, Versailles, France; Copyright; Avail: Other Sources

Total flash counts derived from the North Alabama Lightning Mapping Array are being processed for 2002 to form a climatology of total lightning for the Tennessee Valley region. The data from this active and interesting period will be compared to data fiom the National Lightning Detection Network, space-based lightning sensors, and weather radars.
Author
Lightning; Climatology; Meteorological Radar

20030061403 NASA Marshall Space Flight Center, Huntsville, AL, USA
The Influence of Environmental State on Lightning and Convective Parameter Distributions
Boccippio, D.; Heckman, S.; Renno, N. O.; Christopher, P.; Millty, D.; [2002]; 1 pp.; In English; 2002 American Geophysical Union Fall Meeting, 6-10 Dec. 2002, San Francisco, CA, USA; No Copyright; Avail: Other Sources; Abstract Only

A merged and highly reduced database of TRMM level 1 (precipitation radar, microwave imager, lightning) and NCEP reanalysis (basic state, radiative and surface flux) data has been assembled for three years of the TRMM mission. This allows direct examination of the dependence of convective spectra (as observed through radar reflectivity, microwave brightness temperature and lightning flash rate) on environmental basic states and anomalies. Such analysis may be more physically justified and instructive than traditional geographic and/or seasonal binning. The dependence of convective spectra on several environmental forcing parameters is presented, including surface Bowen ratio (sensible heat to total turbulent flux), net atmospheric radiative flux convergence and net atmospheric enthalpy flux convergence. The latter are basic drivers of net moisture convergence in simple quasi-equilibrium models of tropical atmospheric convection.
Author
Atmospheric Circulation; Atmospheric Models; Lightning; Convection; Data Bases; Precipitation (Meteorology); Microwave Imagery

20030061413 NASA Marshall Space Flight Center, Huntsville, AL, USA
Atmospheric Electrical Activity and the Prospects for Improving Short-Term, Weather Forcasting
Goodman, Steven J.; [2003]; 1 pp.; In English; International Conference on Atmospheric Electricity ICAE 2003, 9-13 Jun. 2003, Versailles, France; No Copyright; Avail: Other Sources; Abstract Only

How might lightning measurements be used to improve short-term (0-24 hr) weather forecasting? We examine this question under two different prediction strategies. These include integration of lightning data into short-term forecasts (nowcasts) of convective (including severe) weather hazards and the assimilation of lightning data into cloud-resolving numerical weather prediction models. In each strategy we define specific metrics of forecast improvement and a progress assessment. We also address the conventional observing system deficiencies and potential gap-filling information that can be addressed through the use of the lightning measurement.
Author
Lightning; Atmospheric Electricity; Numerical Weather Forecasting; Atmospheric Models

20030061417 NASA Marshall Space Flight Center, Huntsville, AL, USA

Preliminary Optical And Electric Field Pulse Statistics From Storm Overflights During The Altus Cumulus Electrification Study

Mach, D. A.; Blakeslee, R. J.; Bailey, J. C.; Farrell, W. M.; Goldberg, R. A.; Desch, M. D.; Houser, J. G.; [2003]; 1 pp.; In English; International Conference Atmospheric Electricity 2003, 9-13 Jun. 2003, Versailles, France; Copyright; Avail: Other Sources; Abstract Only

The Altus Cumulus Electrification Study (ACES) was conducted during the month of August, 2002 in an area near Key West, Florida. One of the goals of this uninhabited aerial vehicle (UAV) study was to collect high resolution optical pulse and electric field data from thunderstorms. During the month long campaign, we acquired 5294 lightning generated optical pulses with associated electric field changes. Most of these observations were made while close to the top of the storms. We found filtered mean and median 10-10\% optical pulse widths of 875 and 830 microns respectively while the 50-50\% mean and median optical pulse widths are 422 and 365 microns respectively. These values are similar to previous results as are the 10-90\% mean and median rise times of 327 and 265 microns. The peak electrical to optical pulse delay mean and median were 209 and 145 microns which is longer than one would expect from theoretical results. The results of the pulse analysis will contribute to further validation of the Optical Transient Detector (OTD) and the Lightning Imaging Sensor (LIS) satellites. Pre-launch estimates of the flash detection efficiency were based on a small sample of optical pulse measurements associated with less than 350 lightning discharges collected by NASA U-2 aircraft in the early 1980s. Preliminary analyses of the ACES measurements show that we have greatly increased the number of optical pulses available for validation of the LIS and other orbital lightning optical sensors. Since the Altus was often close to the cloud tops, many of the optical pulses are from low-energy pulses. From these low-energy pulses, we can determine the fraction of optical lightning pulses below the thresholds of LIS, OTD, and any future satellite-based optical sensors such as the geostationary Lightning Mapping Sensor. Author

Atmospheric Electricity; Electromagnetic Pulses; Thunderstorms; Optical Measurement; Electric Fields

20030061424 NASA Marshall Space Flight Center, Huntsville, AL, USA

Relationships between Electrical and Radar Characteristics of Thunderstorms Observed During ACES

Buechler, Dennis E.; Mach, Douglas M.; Blakeslee, Richard J.; [2003]; 1 pp.; In English; International Conference on Atmospheric Elecetricity 2003, 9-13 Jun. 2003, Versailles, France; Copyright; Avail: CASI; A01, Hardcopy

The Altus Cumulus Electrification Study (ACES) took place near Key West, Florida during August 2002. A high altitude, remotely piloted aircraft obtained optical pulse and electric field data over a number of thunderstorms during the study period. Measurements of the vertical electric field and cross sections of radar reflectivity along the flight track are shown for 2 overpasses of a thunderstorm that occurred on 10 August 2002.

Author

Cumulus Clouds; Thunderstorms; Electrification; Meteorological Radar; Electric Fields; Electrical Measurement; Radar Measurement

20030061425 NASA Marshall Space Flight Center, Huntsville, AL, USA

Multi-Satellite Observations of Oceanic Lightning

Boeck, W. L.; Jacobson, A. R.; Christian, H. J.; Goodman, S. J.; [2003]; 1 pp.; In English; 12th International Conference on Atmosphere Electricity 2003, 9-14 Jun. 2003, Versailles, France; Copyright; Avail: CASI; A01, Hardcopy

This paper will present several case studies of active oceanic lightning storms. Measurements by instruments on the Tropical Rainfall Measuring Mission (TRMM) and Fast On-orbit Recording of Transient Events (FORTE) platforms demonstrate that the two sets of sensors reinforce and complement one another. There is spatial and temporal coincidence between the optical data sets from Lightning Imaging Sensor (LIS) on TRMM and the photo-diode detector on FORTE. The LIS flash analysis provides a framework to interpret the stroke level data from FORTE. For these cases, the VHF receiver on FORTE is slaved to the optical system to provide stroke level radio frequency (RF) diagnostics. The occasions when TRMM and FORTE simultaneously have a lightning storm in their overlapping fields of view are extremely rare. One case study in the Gulf of Mexico is within range of land based sensor networks. These networks confirm the interpretation of satellite data and well as provide context for the storm conditions.

Author

Thunderstorms; Lightning; Marine Meteorology; Imaging Techniques; Optical Measuring Instruments

48
OCEANOGRAPHY

Includes the physical, chemical and biological aspects of oceans and seas; ocean dynamics; and marine resources. For related information see also *43 Earth Resources and Remote Sensing*.

20030060418 NASA Goddard Space Flight Center, Greenbelt, MD, USA
The Proposal for the NASA Sensor Intercalibration and Merger for Biological and Interdisciplinary Oceanic Studies(SIMBIOS) Program, 1995
McClain, Charles; Esaias, Wayne; Feldman, Gene; Gregg, Watson; Hooker, Stanford; Frouin, Robert; April 2002; 55 pp.; In English
Report No.(s): NASA/TM-2002-210008; Rept-000137; NAS 1.15:210008; Copyright; Avail: CASI; A04, Hardcopy

As a result of the Earth Observing System (EOS) restructuring exercise during the last half of fiscal year 1994, the EOS Color mission, which was scheduled to be a data-buy with a 1998 launch was dropped from the EOS mission manifest primarily because of the number of international ocean color missions scheduled for launch in the 1998 time frame. In lieu of a new mission, NASA Goddard Space Flight Center (GSFC) was tasked by NASA Headquarters to develop an ocean color satellite calibration and validation plan for multiple sensors. The objective of the activity was to develop a methodology and operational capability to combine data products from the various ocean color missions in a manner that ensures the best possible global coverage and data quality. The program was called the Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) project coined from the biological term 'symbiosis.' This document is the original proposal that was developed and submitted in May 1995. SIMBIOS was approved in 1996 and initiated in 1997 with a project office and technical staff at GSFC and a science team to assist in the development of validation data sets, sensor calibration, atmospheric correction, and bio-optical and data merger algorithms. Since its inception, the SIMBIOS program has resulted in a broad-based international collaboration on the calibration and validation of a number of ocean color satellites. Author

Intercalibration; Oceanography; Water Color; Biosphere; Sensors; NASA Programs; Marine Biology

20030060619 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Comparing SeaWiFS Reprocessing Versions (R3 vs. R4)
Casey, Nancy W.; Gregg, Watson; April 2003; 27 pp.; In English; Original contains color illustrations
Report No.(s): NASA/TM-2003-212235; Rept-2003-01583-0; NAS 1.15:212235; No Copyright; Avail: CASI; A03, Hardcopy

Satellite observations of global ocean chlorophyll from SeaWiFS were recently reprocessed to incorporate calibration and algorithm improvements. Here, comparisons are made between the newly reprocessed SeaWiFS Level-3 chlorophyll product and the previous version using in situ measurements. The results show that the newly reprocessed SeaWiFS data matches up better with the surface measurements than the previous version did. Globally, the slope of the match-ups improves to 0.85 from 0.78 in log-log scale. A significant trend that contributed to this improvement was the overall decrease in SeaWiFS chlorophyll levels less than 1.0 mg m(exp -3). Regional analyses reveal that the matchups improve in every oceanic basin, except the Antarctic. However, SeaWiFS continues to exhibit poor correspondence with in situ data in the North Atlantic where the match-ups have a slope of 0.54. Also, an examination of monthly images for May 1999 revealed that the number and magnitude of high-value chlorophyll pixels had increased in the high-latitude open ocean of the South Pacific.
Author

Sea-Viewing Wide Field-Of-View Sensor; Chlorophylls; Algorithms; Quality Control; Remote Sensing; Computer Programming; Data Processing

51
LIFE SCIENCES (GENERAL)

Includes general research topics related to plant and animal biology (non-human); ecology; microbiology; and also the origin, development, structure, and maintenance of animals and plants in space and related environmental conditions. For specific topics in life sciences see *categories 52 through 55*.

20030060536 Pennsylvania Univ., Philadelphia, PA, USA
The Effect of Simulated Microgravity Environment of RWV Bioreactors on Surface Reactions and Adsorption of Serum Proteins on Bone-bioactive Microcarriers
Radin, Shula; Ducheyne, P.; Ayyaswamy, P. S.; 2002 Microgravity Materials Science Conference; February 2003, pp. 188-197; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAG8-1483; No Copyright; Avail: CASI; A02, Hardcopy

Biomimetically modified bioactive materials with bone-like surface properties are attractive candidates for use as microcarriers for 3-D bone-like tissue engineering under simulated microgravity conditions of NASA designed rotating wall vessel (RWV) bioreactors. The simulated microgravity environment is attainable under suitable parametric conditions of the RWV bioreactors. Ca-P containing bioactive glass (BG), whose stimulatory effect on bone cell function had been previously demonstrated, was used in the present study. BG surface modification via reactions in solution, resulting formation of bone-like minerals at the surface and adsorption of serum proteins is critical for obtaining the stimulatory effect. In this paper, we report on the major effects of simulated microgravity conditions of the RWV on the BG reactions surface reactions and protein adsorption in physiological solutions. Control tests at normal gravity were conducted at static and dynamic conditions. The study revealed that simulated microgravity remarkably enhanced reactions involved in the BG surface modification, including BG dissolution, formation of bone-like minerals at the surface and adsorption of serum proteins. Simultaneously, numerical models were developed to simulate the mass transport of chemical species to and from the BG surface under normal gravity and simulated microgravity conditions. The numerical results showed an excellent agreement with the experimental data at both testing conditions.
Author
Adsorption; Bioreactors; Bones; Microgravity; Proteins; Serums; Surface Reactions; Computerized Simulation; Biomimetics

20030061122 NASA Marshall Space Flight Center, Huntsville, AL, USA
Photoabsorption study of Bacillus megaterium, DNA and Related Biological Materials in the Phosphorus K-edge Region
Frigo, Sean P.; McNulty,Ian; Richmond, Robert C.; Ehret, Charles F.; January 2003; 2 pp.; In English; Copyright; Avail: Other Sources

We have measured the x-ray transmission spectra of several biologically related samples in the phosphorus K-edge absorption region. These include red phosphorus, hydrated sodium phosphate (Na3PO4 12 H2O), deoxyribonucleic acid (DNA), adenosinetriphosphate (ATP), diolylphosphatidyl choline (DOPC), and Bacillus megaterium spores. Red phosphorus essentially displays an edge-jump. All other spectra are similar in form and energy position, where each is dominated by a narrower, more intense first peak and a broader but less intense second peak. The corresponding K-edge absorption thresholds are shifted towards higher energy relative to that for red phosphorus, as expected for increasing degrees of phosphorus oxidation. The B.meguterium spectrum has aspects common to both the phosphate and DNA spectra and is therefore interpreted as a composite of spectra arising from DNA/RNA and phosphates within the spore. The B. megaterium spore spectrum provides needed information for resonant radiation damage studies in the phosphorus K-edge absorption region by identifying candidate photoexcitations. In addition, the absorption spectra will be useful in macromolecular crystallography studies employing anomalous dispersion effects at the phosphorus K-edge.
Author
Bacillus; Deoxyribonucleic Acid; Photoabsorption; Phosphorus; Ribonucleic Acids

20030061203 Memphis Univ., Memphis, TN, USA
Modeling Cyclic Variation of Intracranial Pressure
Daley, M. L.; Pasley, R. L.; Leffler, C. W.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A410875; No Copyright; Avail: CASI; A01, Hardcopy

To test the theoretical feasibility that low frequency baseline changes of the intracranial pressure (ICP) recording during mechanical ventilation are due to cyclic extravascular compressional modulation primarily of the cerebral venous bed, an established isovolumetric model of cerebrospinal fluid dynamics proposed by Ursino was modified. These modifications were made to address the hypothesis that: (1) cyclic extravascular compressional modulation of the cerebral venous bed occurs during positive pressure inhalation, and (2) the degree of modulation is diminished with increasing vascular dilation induced by increasing the level of the partial pressure of carbon dioxide (PC02) within the arterial blood. Modification of the isovolumetric model was accomplished by introducing a cyclic modulation of the resistance of the cerebral venous bed synchronized with ventilation. Simulated model recordings demonstrated that the correlation index between arterial blood pressure and ICP progressively increased monotonically as the level of PC02 increased from 30 mmHg to 80 mmHg. These results support the premise that during positive pressure ventilation, cyclic extravascular compressional modulation of primarily the cerebral venous bed produces a cyclic variation of ICP and the degree of modulation is dependent on the state of vascular dilation. The potential clinical application of these results is that patients with severe head injury who demonstrate a strong correlation between the ICP and arterial blood pressure recordings are likely to have a high transmural venous

pressure indicative of maximal dilation, loss of autoregulation of cerebral blood flow, and the subsequent development of cerebral edema.
DTIC
Brain; Diagnosis; Hydrodynamics; Veins; Arteries; Blood Pressure; Respiration; Vasodilation; Cerebrospinal Fluid; Exhalation

20030061209 NASA Marshall Space Flight Center, Huntsville, AL, USA
Activation of Cyclic AMP Synthesis by Full and Partial Beta-Adrenergic Receptor Agonists in Chicken Skeletal Muscle Cells
Young, R. B.; Bridge, K. Y.; [2003]; 1 pp.; In English; Molecular Biology of Muscle Development and Regeneration Conference, 29 May - 4 Jun. 2003, Banff, Canada; No Copyright; Avail: Other Sources; Abstract Only

Several beta-adrenergic receptor (bAR) agonists are known to cause hypertrophy of skeletal muscle tissue. Accordingly, five bAR agonists encompassing a range in activity from strong to weak were evaluated for their ability to stimulate CAMP accumulation in embryonic chicken skeletal muscle cells in culture. Two strong agonists (epinephrine and isoproterenol), one moderate agonist (albuterol), and two weak agonists known to cause hypertrophy in animals (clenbuterol and cimaterol) were studied. Dose response curves were determined over six orders of magnitude in concentration for each agonist, and values were determined for their maximum stimulation of CAMP synthesis rate (Bmax) and the agonist concentration at which 50\% stimulation of CAMP synthesis (EC50) occurred. Bmax values decreased in the following order: isoproterenol, epinephrine, albuterol, cimaterol, clenbuterol. Cimaterol and clenbuterol at their Bmax concentrations were approximately 15-fold weaker than isoproterenol in stimulating the rate of CAMP synthesis. When cimaterol and clenbuterol were added to culture media at concentrations known to cause significant muscle hypertrophy in animals, there was no detectable effect on stimulation of CAMP synthesis. Finally, these same levels of cimaterol and clenbuterol did not antagonize the stimulation of CAMP by either epinephrine or isoproterenol.
Author
Adrenergics; Animals; Cyclic Amp; Musculoskeletal System; Cells (Biology); Synthesis (Chemistry); Receptors (Physiology)

20030061237 NASA Marshall Space Flight Center, Huntsville, AL, USA
Two Strategies for Microbial Production of an Industrial Enzyme-Alpha-Amylase
Bernhardsdotter, Eva C. M. J.; Garriott, Owen; Pusey, Marc L.; Ng, Joseph D.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

Extremophiles are microorganisms that thrive in, from an anthropocentric view, extreme environments including hot springs, soda lakes and arctic water. This ability of survival at extreme conditions has rendered extremophiles to be of interest in astrobiology, evolutionary biology as well as in industrial applications. Of particular interest to the biotechnology industry are the biological catalysts of the extremophiles, the extremozymes, whose unique stabilities at extreme conditions make them potential sources of novel enzymes in industrial applications. There are two major approaches to microbial enzyme production. This entails enzyme isolation directly from the natural host or creating a recombinant expression system whereby the targeted enzyme can be overexpressed in a mesophilic host. We are employing both methods in the effort to produce alpha-amylases from a hyperthermophilic archaeon (Thermococcus) isolated from a hydrothermal vent in the Atlantic Ocean, as well as from alkaliphilic bacteria (Bacillus) isolated from a soda lake in Tanzania. Alpha-amylases catalyze the hydrolysis of internal alpha-1,4-glycosidic linkages in starch to produce smaller sugars. Thermostable alpha-amylases are used in the liquefaction of starch for production of fructose and glucose syrups, whereas alpha-amylases stable at high pH have potential as detergent additives. The alpha-amylase encoding gene from Thermococcus was PCR amplified using carefully designed primers and analyzed using bioinformatics tools such as BLAST and Multiple Sequence Alignment for cloning and expression in E.coli. Four strains of Bacillus were grown in alkaline starch-enriched medium of which the culture supernatant was used as enzyme source. Amylolytic activity was detected using the starch-iodine method.
Author
Biotechnology; Enzymes; Industries; Microorganisms; Exobiology

20030061252 Budapest Univ. of Technology and Economics, Budapest, Hungary
Efficient ECG Signal Compression Using Adaptive Heart Model
Szilagyi, S. M.; Szilagyi, L.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A410874; No Copyright; Avail: CASI; A01, Hardcopy

This paper presents an adaptive, heart-model-based electrocardiography (ECG) compression method. After conventional

pre-filtering the waves from the signal are localized and the model's parameters are determined. The structure of the algorithm allows real-time adaptation to the heart's state. The compression, for better comparison, was performed for one and more channels from the MIT/BIH database samples. The compression ratio depends on the maximal allowed root mean square reconstruction error (RMSRE). As a second classification criterion the authors applied the performance of the signal detection method from the compacted data. They used an adaptive entropy encoder to reduce the redundancy. The major advantage of this method is that it allows the possibility of accomplishing a real-time, adaptive, and patient-specific encoding with relatively low computational power, which would be ideal for telemetry measurements.
DTIC
Signal Processing; Diagnosis; Electrocardiography; Arrhythmia

52
AEROSPACE MEDICINE

Includes the biological and physiological effects of atmospheric and space flight (weightlessness, space radiation, acceleration, and altitude stress) on the human being; and the prevention of adverse effects on those environments. For psychological and behavioral effects of aerospace environments, see *53 Behavioral Sciences*. For the effects of space on animals and plants see *51 Life Sciences*.

20030060486 Army Research Inst. of Environmental Medicine, Natick, MA
Real Time Thermoregulatory Model for Extreme Cold Stress: Applicable to Objective Force Warrior (OFW)
Xu, Xiaojiang; Giesbrecht, Gordon; Gonzalez, Richard; Jan. 2003; 72 pp.; In English
Report No.(s): AD-A411791; No Copyright; Avail: CASI; A04, Hardcopy

A mathematical model for predicting shivering and thermoregulatory responses during long term cold exposure has been developed and validated. The basis for this model is a six-cylinder mathematical model of human temperature regulation which was well validated (Xu and Werner, Appl. Human Sci. 16:61-75, 1997) for dynamic conditions: incorporating heat, cold (less than 2 hours), clothing systems, and exercise. To what extent shivering is maintained over a long duration is not clearly known and a modeling technique has been sought to predict such responses.
DTIC
Thermoregulation; Mathematical Models; Cold Tolerance; Fatigue (Biology)

20030060695 California Univ., Irvine, CA
Physiological Stress Reactivity and Breast Cancer
Wadhwa, Pathik D.; Oct. 2002; 5 pp.; In English
Contract(s)/Grant(s): DAMD17-99-1-9248
Report No.(s): AD-A412715; No Copyright; Avail: CASI; A01, Hardcopy

The objective of the present program of research is to study physiological processes that may mediate the links between psychological states and cancer. Specifically, the present study is designed to conduct an investigation of the cross-sectional associations between indices of stress reactivity and psychological coping styles in women with breast cancer and matched healthy controls. The aims of the project are: (1) To quantify parameters of biological reactivity to a behavioral stress paradigm in women with and without breast cancer; (2) To examine (a) group differences between women with and without breast cancer in biological stress reactivity, and (b) the effects of menopause and familial risk on biological stress reactivity and emotional expression; and (3) To develop the methodology and obtain preliminary data which could justify subsequent, prospective research with high-risk populations.
DTIC
Data Bases; Cancer; Mammary Glands

54
MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human factors engineering, bionics, man-machine systems, life support, space suits and protective clothing. For related information see also *16 Space Transportation and Safety* and *52 Aerospace Medicine*.

20030059491 Shizuoka Univ., Japan
A Pilot Study on Ultrasonic Sensor-Based Measurement of Head Movement
Nunoshita, M.; Ebisawa, Y.; Marui, T.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A411902; No Copyright; Avail: CASI; A01, Hardcopy

In the present paper, we propose a high-performance, ultrasonic sensor-based head movement detection system, which can be easily applied as an eye tracking device by rotating a mirror set in front of a video camera in a head-free video-based eye-gaze detection system. We propose a simple distance measurement method that uses an A-D converter and an envelope detection method. Experimental results indicate small standard deviations of less than 0.9 mm when the distance between transmitter and receiver is within the range of 40 - 80 cm. In addition, we arranged three transmitters of the apices of a triangle to simulate the head of the user. The receivers were arranged on the apices of a larger triangle. The coordinates of each transmitter were determined using the measured distances from the transmitter to the three receivers. The center of gravity of the three transmitters and the normal vector of the plane that includes the three transmitters were calculated based of the estimated coordinates of the three transmitters. The results indicate sufficiently high precision and measuring frequency for our purpose. The proposed method would be useful for adjusting the focus of a zoom lens to the eye, as well as adjusting the direction of the mirror to the eye.
DTIC
Ultrasonics; Man Machine Systems; Head (Anatomy); Head Movement; Eye Movements

20030059509 Sytronics, Inc., Dayton, OH
Antropometric Research on the Sizing of the MBU-20/P Aircrew Oxygen Mask
Gross, Mary E.; Taylor, Stacie E.; Mountjoy, Daniel N.; Hoffmeister, Jeff; Nov. 1997; 135 pp.; In English
Contract(s)/Grant(s): F41624-93-C-6001; Proj-7184
Report No.(s): AD-A412358; AFRL-HE-WP-TR-2002-0181; No Copyright; Avail: CASI; A07, Hardcopy

The goal of this study was to determine sizing recommendation to improve the fit of the MBU-20/P Advanced Aircrew Oxygen Mask (AAOM). The approach was to do a fit test of the mask using the current sizes and the latest anthropometric measuring technology, then analyze the differences between subjects who passed and those who failed. This was done in conjunction with an effort to develop a customization process method for the soft rubber portion of the mask. This sizing study concentrates on improving the fit of the hard shell. The sizes currently available are SN (Small Narrow), MN (Medium Narrow), MW (Medium Wide), and LW (Large Wide). While it was hypothesized at the outset that the fit could be improved by adding a size, the fit results indicated that this was not the case. Instead, the location of the mask with respect to the face seemed to be an overriding factor.
DTIC
Anthropometry; Flight Crews; Oxygen Masks

20030060476 Embry-Riddle Aeronautical Univ., AZ, USA
Effect of Projection Visor Transmissivity and Reflectivity Level on Visual Acuity in Low Light Conditions
Smith, Mark K.; Sep. 2001; 90 pp.; In English
Contract(s)/Grant(s): Proj-7184
Report No.(s): AD-A412578; AFRL-HE-WP-TR-2002-0228; No Copyright; Avail: CASI; A05, Hardcopy

The purpose of this study was to determine the effect of projection visor transmission and reflection properties on a pilot's ability to detect a visual target. Five visor configurations were used to analyze the effect of transmissivity. They were no visor, a visually coupled acquisition and targeting systems (VCATS) 50\% visor, VCATS 35\% visor, VCATS 25\% uncoated visor, and a standard USAF 12\% visor. Two visors were used to analyze the effect of reflectivity. They were a VCATS 25\% uncoated visor and a VCATS 24\% coated visor. Results showed there was a reduction in mean target detection range with a decrease in visor transmissivity except for the paring of no visor to the VCATS 50\% visor and the VCATS 35\% visor to the VCATS 25\% uncoated visor. In these two comparisons no statistical significance was found in detection range. No statistical significance was found in the detection range for the visors used in the reflectivity analysis.
DTIC
Helmet Mounted Displays; Transmissivity; Target Recognition

20030061080 MathCraft Consulting, Dayton, OH, USA
A Statistical Analysis of the Sizing System for the Advanced Technology Anti-G Suit (ATAGS)
Wheeler, T. A.; Gross, Mary E.; Crist, John T.; Robinette, Kathleen M.; Sep. 1994; 83 pp.; In English
Contract(s)/Grant(s): F33615-89-C-0572; F41624-03-C-6001; Proj-7184
Report No.(s): AD-A412704; AFRL-HE-WP-TR-2002-8174; No Copyright; Avail: CASI; A05, Hardcopy

The current Anti-G suite sizing system appears adequate for the male target population. It covers approximately 98.5\% of that population. Three sizes are found to be candidates for elimination from the system: Sizes 7, 3, and 8. Several

opportunities exist for system improvement by reproportioning some sizes. Recommendations were made for reproportioning sizes for men. Waist Circumference (at Iliocristable)) and Crotch Height were identified as the key anthropometric dimensions for distinguishing suit sizes. The procurement tariff resulting from this analysis differs significantly from that projected based on design criteria. Female data were collected in conjunction with the men, but analyzed and reported separately. It was clear that large proportional differences in the waist versus the hip made the suits unacceptable for many women. It was apparent that this type of Anti-G suit required sizes specifically proportioned for the female form. Past studies indicate that source of the problem, and the female data analysis includes results and comparisons from other studies. Size recommendations for women were made based on that analysis.
DTIC
Anthropometry; Size (Dimensions); Space Suits

59
MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

Includes general topics and overviews related to mathematics and computer science. For specific topics in these areas see *categories 60 through 67*.

20030059525 Swedish Defence Research Establishment, Stockholm, Sweden
Differential Geometric Aspects of Optimal Control
Vooren, C. N.; Jan. 2002; 50 pp.; In English
Report No.(s): PB2003-104348; FOI-R-0521-SE; No Copyright; Avail: CASI; A03, Hardcopy

This master thesis has been done within the Optimization of Missile Performance Project at the department of Autonomous Systems at FOI. Increasing demands on missiles call for more sophisticated control methods. In this contest optimization and differential geometry are of great interest. The theory of optimal control has an underlying differential geometric structure which is explored in the present thesis.
NTIS
Autonomy; Differential Geometry; Optimal Control; Calculus Of Variations

60
COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware and data processing. For components see *33 Electronics and Electrical Engineering*. For computer vision see *63 Cybernetics, Artificial Intelligence and Robotics*.

20030060672 Osaka Electro-Communication Univ., Japan
Mouse Cursor Control System Using EMG
Itou, Tetsuya; Terao, Muneaki; Nagata, Junji; Yoshida, Masaki; Oct. 25, 2001; 3 pp.; In English
Report No.(s): AD-A412406; No Copyright; Avail: CASI; A01, Hardcopy

The amputee cannot operate a mouse freely when they use personal computer. Also there are few people who think it easy to use computers among the old. Then, we develop the new type man machine interface using an electromyogram (EMG). The advantage of EMG is the following two. The first is that, we can control EMG freely. The second is that, what is necessary is just to put electrodes on the skin surface. In this study, the operation of a mouse cursor is reproduced (up, down, left, right, right click, left click). We used EMG for the input and the output of the system is mouse cursor operation. Operation of a mouse cursor was judged by the neural network. The neural network was taken as three inputs, two hidden layers, and the one output layer. We were able to do cursor operation 70\% reappearance as a result.
DTIC
Microcomputers; Electromyography; Disabilities

20030061386 Air Force Research Lab., Rome, NY, USA
Graphical Interface Concept for a Signal Detection Process
Costello, Brian; Feb. 2003; 36 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): Proj-459E
Report No.(s): AD-A411321; AFRL-IF-RS-TM-2003-1; No Copyright; Avail: CASI; A03, Hardcopy

A concept is presented for a graphical interface to the Adjustable Bandwidth Concept (ABC) signal energy detection

process, U.S. Patent 5,257,211. To verify the utility and effectiveness of the interface, a MATLAB (Mathworks, Inc) implementation has been developed. The emphasis is on those applications which would require real-time processing. Although the implementation itself does not run in real-time for higher sampling rates, it does serve as a design that can be used in the development of such systems.
DTIC
Algorithms; Graphical User Interface; Signal Detection; Signal Processing

61
COMPUTER PROGRAMMING AND SOFTWARE

Includes software engineering, computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM. For computer software applied to specific applications, see also the associated category.

20030059484 Illinois Univ., Urbana-Champaign, IL, USA, Argonne National Lab., IL
Automatic Differentiation of a Parallel Molecular Dynamics Application
Hovland, P.; Bischof, C.; Roh, L.; Dec. 31, 1998; 12 pp.; In English
Report No.(s): DE2003-555543; No Copyright; Avail: Department of Energy Information Bridge
The ADIC and ADIFOR automatic differentiation tools have proven useful for obtaining the derivatives needed in many scientific applications written in Fortran 77 or ANSI C. But many new scientific programs are written for or ported to parallel platforms to achieve maximal performance. We provide an overview of our approach to the complex taks of applying automatic differentiation techniques to parallel programming environments, especially as applied to a parallel molecular dynamics application written in C++ with PVM message passing.
NTIS
Molecular Dynamics; Applications Programs (Computers); Computer Programming

20030059506 Carnegie-Mellon Univ., Pittsburgh, PA
Architecture Reconstruction Guidelines, 2nd Edition
Kazman, Rick; O'Brien, Liam; Verhoef, Chris; Dec. 2002; 42 pp.; In English
Contract(s)/Grant(s): F196200-00-C-0003
Report No.(s): AD-A412306; CMU/SEI-2002-TR-034; ESC-TR-2002-034; No Copyright; Avail: CASI; A03, Hardcopy
Architecture reconstruction is the process of obtaining the 'as-built' architecture of an implemented system from the existing legacy system. For this process, tools are used to extract information about the system that will assist in building successive levels of abstraction. Although generating a useful representation is not always possible, a successful reconstruction results in an architectural representation that aids in reasoning about the system. This recovered representation is most often used as a basis for redocumenting the architecture of an existing system if the documentation is out of date or nonexistent, and can be used to check the 'as-built' architecture against the 'as-designed' architecture. The architectural representation can also be used as a starting point for reengineering the system to a new desired architecture. Finally, the representation can be used to help identify components for reuse or to help establish a software product line. This report describes the process of architecture reconstruction using the Dali architecture reconstruction workbench. Guidelines are presented for reconstructing the architectural representations of existing systems. Most of these guidelines are not specific to the Dali tool, can be used with other tools, and are useful even if the architecture reconstruction is carried out manually.
DTIC
Architecture (Computers); Computer Systems Design; Software Development Tools

20030060407 Technical Research Centre of Finland, Espoo, Finland
Cost-Effective Reliability Design and Assessment of Software, Part 2
Harju, H.; Koskela, M.; 2003; 116 pp.; In Finnish
Report No.(s): PB2003-104689; VTT-RN-2193-Pt-2; Copyright; Avail: National Technical Information Service (NTIS)
Software is increasingly being used in critical applications. Unlike most hardware failures, software failures are systematic and software faults may lie hidden for a long time before being revealed. This publication is a second part of research project which study cost effective design and assessment of software dependability. Three specific themes are introduced: why software methods are not used in practice, test automation in demonstrating software dependability, failure

mechanisms and software metrics utilized in software dependability assessment.
NTIS
Computer Programs; Software Engineering; Software Reliability; Computer Programming

20030060409 Massachusetts Inst. of Tech., Cambridge, MA
A Density Evolution Analysis of Turbo Product Codes
Durham, Laura M.; Jun. 2002; 114 pp.; In English
Report No.(s): AD-A412466; MIT-CI02-802; No Copyright; Avail: CASI; A06, Hardcopy

Turbo product codes (TPC) are a promising approach for power-efficient communications, particularly in satellite and terrestrial wireless systems. These codes use an iterative decoding method similar to turbo codes. TPCs have been shown to have a bit error rate (BER) performance within a couple of dB of turbo codes without the error floor, however other performance measures of turbo product codes are not well developed. This thesis applies the Extrinsic Information Transfer (EXIT) chart analysis, developed for turbo codes, to turbo product codes. The EXIT chart analysis allows for examination of the evolution of the probability densities of the information passed from iteration to iteration of the decoder. The analysis begins with the EXIT chart analysis for two-dimensional TPCs, similar to the turbo code results, and then extends the analysis to three-dimensional TPCs. Binary phase-shift keying (BPSK) and Gaussian minimum-shift keying (GMSK) modulations are examined in both an unfaded additive white Gaussian noise (AWGN) as well as Rayleigh faded channel. In addition, BER results are predicted in the low E (sub b)/N (sub o) region, convergence thresholds determined, and lastly a new code construction for a rate 1/2 TPC is designed.
DTIC
Probability Density Functions; Error Correcting Codes

20030060443 Integrated Sensors, Inc., Utica, NY, USA
Power Aware Signal Processing Environment (PASPE) for PAC/C
Castellano, Cosmo; Solsky, Karen; Ivory, John; Graham, Jim; Feb. 2003; 94 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F30602-00-C-0150; Proj-PASP
Report No.(s): AD-A412245; AFRL-IF-RS-TR-2003-24; No Copyright; Avail: CASI; A05, Hardcopy

The ISI Power Aware Signal Processing Environment Program was focused on developing a capability to allow system designers to implement orders of magnitude reduction in system power by intelligently controlling those factors that influence power consumption. ISI provided an embedded hardware configuration and software tools to support Power Aware concepts and application programming.
DTIC
Signal Processing; Computer Programming; Architecture (Computers); Programming Environments

20030060457 Technical Research Centre of Finland, Espoo, Finland
Agile Software Development Methods. Review and Analysis
Abrahamsson, P.; Salo, O.; Ronkainen, J.; Warsta, J.; 2002; 116 pp.; In English
Report No.(s): PB2003-105025; VTT-PUB-478; No Copyright; Avail: CASI; A06, Hardcopy

Agile - demoting 'the quality of being agile; readiness for motion; nimbleness, activity, dexterity in motion' - software development methods are attempting to offer an answer to eager business community asking for lighter weight along with faster and nimbler software development processes. This is especially the case with the rapidly growing and volatile Internet software industry as well as for the emerging mobile application environment. The new agile methods have evoked a substantial amount of literature and debates. However, academic research on the subject is still scarce, as most of existing publications are written by practitioners or consultants.
NTIS
Software Engineering; Computer Programming

20030060483 Carnegie-Mellon Univ., Pittsburgh, PA
Predictable Assembly of Substation Automation Systems: An Experiment Report
Hissam, Scott; Hudak, John; Ivers, James; Klein, Mark; Larsson, Magnus; Sep. 2002; 164 pp.; In English
Contract(s)/Grant(s): F19628-00-C-0003
Report No.(s): AD-A411970; CMU/SEI-2002-TR-031I; ESC-TR-2002-031; No Copyright; Avail: CASI; A08, Hardcopy

The Predictable Assembly from Certifiable Components (PACO) Initiative at the Software Engineering Institute (SEIsM) is developing methods and technologies for predictable assembly. A software development activity that builds systems from components is predictable if the runtime behavior of an assembly of components can be predicted from known properties of components and their patterns of interactions (connections), and if these predictions can be objectively validated. A component is certifiable if these known properties can be obtained or validated by independent third parties. The SEI's technical approach to PACC rests on prediction-enabled component technology (PECT). At the highest level, PECT is a scheme for systematic and repeatable integration of software component technology, software architecture technology, and design analysis and verification technology. This report describes the results of an exploratory PECT prototype for substation automation, an application area in the domain of power generation, transmission, and management. This report focuses primarily on the methodological aspects of PECT, the prototype itself was only a means to expose and illustrate the PECT method.
DTIC
Computer Programming; Automation; Prototypes; Technology Utilization

20030060593 Army Tank-Automotive and Armaments Command, Warren, MI
Health Monitoring and Diagnostics of Ground Combat Vehicle
Bankowski, Elena; Miles, Christopher; Saboe, Michael S.; Gilbert, Peggy; Jan. 2001; 10 pp.; In English
Report No.(s): AD-A412754; TACOM-13845; No Copyright; Avail: CASI; A02, Hardcopy

The proposed technology is the Dependable Automated Reconfigurable Software (DARTS). The DARTS health and situation control continually tests the processing elements with Probe/Agent technology. Algorithms within the Health & Situation Control assess the health of the processors based on a criticality scoring system that considers mission requirements. Probes launched by the DARTS controller query processing elements. The probed data is sent to a gauge that has a variable sensitivity or gain. Statistical Usage models and criticality scoring control the sensitivity of the gauge. In response to the gauge, the replicating process launches agents that can insert anomalous events for diagnostic purposes. In this context, a probe is a subset of an agent having only the ability to query without affecting framework, I/O protocol or Quality of Service. Each weapon system fitted with a DARTS Controller will control self-repair and reconfiguration of on-board processors utilizing a statistical based intelligent scoring system. It considers criticality of the function in the current battlefield situation. DARTS is a software system that enhances the performance of a weapon system by providing on-the-fly reconfiguration to accommodate the loss or malfunction of processing elements or to optimize onboard performance capability.
DTIC
Systems Health Monitoring; Weapon Systems; Software Engineering; Automation; Combat

20030060653 Manchester Univ., UK
Image Reconstruction Methods for Electrical Impedance Tomography on SUT-1 System
Soleimani, M.; Movafeghi, A.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412368; No Copyright; Avail: CASI; A01, Hardcopy

In this paper we describe some software for image reconstruction of electric impedance tomography (ElT) made on Sharif University of Technology named (SUT-1). We will discuss about image reconstruction methods and we will show the results of simulation and real measurement from SUT-1 system.
DTIC
Tomography; Image Reconstruction

20030060679 Maryland Univ., College Park, MD
Ordered and Quantum Treemaps: Making Effective Use of 2D Space to Display Hierarchies
Bederson, Benjamin B.; Shneiderman, Ben; Wattenberg, Martin; Oct. 2002; 24 pp.; In English
Contract(s)/Grant(s): F33615-97-1-1018; Proj-ARPA
Report No.(s): AD-A412684; AFRL-SN-WP-TP-2003-104; No Copyright; Avail: CASI; A03, Hardcopy

Treemaps, a space-filling method for visualizing large hierarchical data sets, are receiving increasing attention. Several algorithms have been previously proposed to create more useful displays by controlling the aspect ratios of the rectangles that make up a treemap. While these algorithms do improve the visibility of small items in a single layout, they introduce instability over time in the display of dynamically changing data, fail to preserve order of the underlying data, and create layouts that are difficult to visually search. In addition, continuous treemap algorithms are not suitable for displaying fixed-sized objects within them, such as images. This paper introduces a new 'strip' treemap algorithm that addresses these shortcomings and analyzes other 'pivot' algorithms that have been recently developed showing the trade-offs between them. These ordered

treemap algorithms ensure that items near each other in the given order will be near each other in the treemap layout. Using experimental evidence from Monte Carlo trials and from actual stock market data, the authors show that, compared to other layout algorithms, ordered treemaps are more stable, while maintaining relatively favorable aspect ratios of the constituent rectangles. A user study with 20 participants clarifies the human performance benefits of the new algorithms. Finally, the authors present quantum treemap algorithms, which modify the layout of the continuous treemap algorithms to generate rectangles that are integral multiples of an input object size. The quantum treemap algorithm has been applied to PhotoMesa, an application that supports browsing of large numbers of images. (4 tables, 15 figures, 16 refs.)
DTIC
Algorithms; Computer Graphics; Display Devices

20030060690 West Virginia Univ., Morgantown, WV
Totally Clairvoyant Scheduling with Relative Timing Constraints
Subramani, K.; Dec. 31, 2002; 25 pp.; In English
Contract(s)/Grant(s): F49620-02-1-0043
Report No.(s): AD-A412261; AFRL-SR-AR-TR-03-0084; No Copyright; Avail: CASI; A03, Hardcopy

Traditional scheduling models assume that the execution time of a job in a periodic job-set is constant in every instance of it execution. This assumption does not hold in real-time systems wherein job execution time is known to vary. A second feature of traditional models is their lack of expressiveness, in that constraints more complex than precedence constraints (for instance, relative timing constraints) cannot be modeled. Thirdly, the schedulability of a real-time system depends upon the degree of clairvoyance afforded to the dispatcher. In this paper, we shall discuss Totally Clairvoyant Scheduling, as modeled within the E-T-C scheduling framework. We show that instantiation of the scheduling framework captures the central issues in a real-time flow-shop scheduling problem and design a polynomial time sequential algorithm for the same. We also introduce an error-minimizing performance metric called Violation Degree and establish that optimizing this metric in a Totally Clairvoyant Scheduling System in NP-Hard.
DTIC
Algorithms; Scheduling

20030060697 Naval Postgraduate School, Monterey, CA
Execution Policies Research and Implementation
Clark, Paul C.; Levin, Timothy E.; Irvine, Cynthia E.; Feb. 2003; 13 pp.; In English
Report No.(s): AD-A412737; NPS-CS-03-003; No Copyright; Avail: CASI; A03, Hardcopy

This research studied the application of a software-based ring execution policy, the type of which has previously been implemented via hardware mechanisms, to an open source operating system. Such an execution policy is orthogonal to, and may he used in conjunction with, other mandatory (viz, secrecy, integrity) and discretionary policies. It allows processes running with otherwise similar privileges (such as the root user or secrecy attributes) to be differentiated with respect to priority or privilege regarding system resources and execution. We have found that it is possible to construct a mandatory ring execution policy whose primary function is to restrict subjects from executing certain file system objects, and that this may result in a more coherent and manageable policy than what can be expected from various discretionary (e.g., policy-bypass or privilege-grouping) mechanisms.
DTIC
Access Control; Document Storage

20030061074 Washington Univ., Saint Louis, MO, USA
Overview of the CORBA Component Model, Chapter 38, Section 6
Claus, Russell W., Technical Monitor; Wang, Nanbor; Schmidt, Douglas C.; ORyan, Carlos; Component-Based Software Engineering; [2001]; 16 pp.; In English
Contract(s)/Grant(s): NCC3-777; Copyright; Avail: Other Sources

The Common Object Request Broker Architecture (CORBA) object model is increasingly gaining acceptance as the industry standard, cross-platform, cross-language distributed object computing model. The recent addition of the CORBA Component Model (CCM) integrates a successful component programming model from EJB, while maintaining the interoperability and language-neutrality of CORBA. The CCM programming model is thus suitable for leveraging proven technologies and existing services to develop the next-generation of highly scalable distributed applications. However, the CCM specification is large and complex. Therefore, ORB providers have only started implementing the specification recently.

As with first-generation CORBA implementations several years ago, it is still hard to evaluate the quality and performance of CCM implementations. Moreover, the interoperability of components and containers from different providers is not well understood yet. By the end of next year, we expect that CCM providers will implement the complete specification, as well as support value-added enhancements to their implementations, just as operating system and ORB providers have done historically. In particular, containers provided by the CCM component model implementation provide quality of service (QoS) capabilities for CCM components, and can be extended to provide more services to components to relieve components from implementing these functionalities in an ad-hoc way (Wang, 2000b). These container QoS extensions provide services that can monitor and control certain aspects of components behaviors that cross-cut different programming layers or require close interaction among components, containers, and operating systems. As CORBA and the CCM evolve, we expect some of these enhancements will be incorporated into the CCM specification.
Derived from text
General Overviews; Mathematical Models; Software Engineering; Architecture (Computers); Object-Oriented Programming; Computer Components

20030061083 Defence Science and Technology Organisation, Edinburgh, Australia
A Common Coalition Toolset
Zalcman, Lucien; Aug. 2002; 32 pp.; In English; Original contains color illustrations
Report No.(s): AD-A410806; DSTO-TR-1335; DODA-AR-012-428; No Copyright; Avail: CASI; A03, Hardcopy

The recent I/ITSEC 2001 Coalition Training Demonstration held between the US, Australian and Dutch Navies demonstrated a valid coalition training exercise using Advanced Distributed Simulation to simultaneously connect military training simulators in the USA, Australia and the Netherlands. Whilst participating in the setting up and running of this exercise each participating nation used whatever tools were available to establish and maintain connectivity and interoperability. As one of the lessons learned from such a coalition exercise, this paper discusses a proposal to make available to all participating coalition nations a Common Coalition Toolset (CCT) which comprises a set of software applications used to establish and maintain connectivity and interoperability for such coalition training demonstrations and/or exercises. This paper describes some of the software applications making up this Common Coalition Toolset and what operating systems / programing tool kits etc. should be considered when creating such Common Coalition Toolset applications.
DTIC
Applications Programs (Computers); Training Simulators; Interfaces; Military Operations

20030061133 National Technical Univ., Athens, Greece
Computer Supported Collaborative Environment for Virtual Simulation of Radiation Treatment Planning
Ntasis, E.; Maniatis, T. A.; Gletsos, M.; Nikita, K. S.; 25 Oct. 2001; 5 pp.; In English
Report No.(s): AD-A411105; No Copyright; Avail: CASI; A01, Hardcopy

A collaborative environment for virtual simulation in radiotherapy treatment planning is presented. The environment architecture is based on both off-line and on-line communication of data under a secure framework and can be directly integrated into the infrastructure of a radiotherapy department. The on-line collaboration is based on the simultaneous execution of all actions at both collaborating sites, and prerequisites the off-line communication of the data set on which the collaboration will be performed. A technical pilot study has been carried out on clinical sites, monitoring the performance of the implementation, and revealed high interactivity during an on-line collaboration session.
DTIC
Virtual Reality; Computerized Simulation; Radiation Therapy; Computer Programming

20030061181 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
A Value Focused Thinking Approach to Software Interface in a Complex Analytical Domain
McGee, Christopher M.; Mar. 25, 2003; 184 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412887; AFIT/GOR/ENS/03-16; No Copyright; Avail: CASI; A09, Hardcopy

The intelligence community is faced with an extensive amount of data. Software programs are being developed to examine this issue of data overload and to develop solutions. The responsibility of making the final software decision lies on the analyst, therefore, the interface is the key to linking the intelligence data to the processing and results. If the interface is difficult and complex, the software will be less likely to be used. A methodology must be created which can objectively evaluate the effectiveness of the interface. This methodology will also measure the improvements in the interface's effectiveness that result when various changes are made to the original software interface. Value focused thinking (VFT) is

a proven methodology that can be applied to this problem. VFT provides an objective methodology to identify the values of an organization. Its hierarchical structure is well suited for handling multi-objective problems, such as identifying the values of software interfaces, The values can be measured and put to a common scale, allowing their contribution to the overall objective to be evaluated, By assigning quantifiable measurements to the components, the multi-objective goal can be evaluated and insight can be provided to the decision makers involved with the intelligence software, VFT was applied to determine what is valued in software's interface to members of the intelligence community, With these values identified, a software that is under development was evaluated against the hierarchy. This provided insight into where improvements could be made to the interface that would provide the greatest benefit. The VFT process also allows for the decision maker to continually reevaluate the software against the hierarchy, enabling continual improvement on the interface while maintaining the values of the intelligence community.
DTIC
Computer Programs; Software Engineering; Artificial Intelligence; Complex Systems

20030061185 Aberdeen Test Center Aberdeen Proving Ground MD, Aberdeen Proving Ground, MD, USA
Research Report Point Reactor Kinetic Analysis
Neher, Daryl E., II; Dec. 2002; 43 pp.; In English; Original contains color illustrations
Report No.(s): AD-A410867; ATC-8653; No Copyright; Avail: CASI; A03, Hardcopy

A computer code was written using a point reactor kinetics model Program results are compared to previous theoretical and APRF empirical pulse data. The program is used to determine temperature transients for different scram failures. The pulse-less tail mode of operation is discussed.
DTIC
Computer Programs; Software Engineering; Reactor Physics

20030061381 Naval Postgraduate School, Monterey, CA
SIMPLE: A Prototype Software Fault-Injection Tool
Acantilado, Neil P.; Acandtilado, Christopher P.; Dec. 2002; 226 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411275; No Copyright; Avail: CASI; A11, Hardcopy

Fault-injection techniques can be used to methodically assess the degree of fault tolerance afforded by a system. In this thesis, we introduce a Java-based, semi-automatic fault-injection test harness, called Software Fault Injection Mechanized Prototype Lightweight Engine (SIMPLE). SIMPLE employs a state-based fault injection approach designed to validate test suites. It also can assist developers to assess the properties of a system such as robustness, reliability, and performance. SIMPLE employs fault acceleration to test a system's fault-tolerant capabilities. We present an object-oriented analysis of the system and several case studies, using software fault injection on specific, targeted systems, to assess SIMPLE's effectiveness.
DTIC
Computer Programs; Software Engineering; Fault Tolerance

20030061402 Air Force Research Lab., Edwards AFB, CA, USA
SUPREM-DSMC Version 1.0 User's Manual
Wadsworth, D. C.; VanGilder, D. B.; Wysong, I. J.; Kaplan, C.; Mott, D.; Jul. 19, 2000; 92 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A411285; AFRL-PR-ED-TP-2000-161; No Copyright; Avail: CASI; A05, Hardcopy

SUPREM-DSMC is a scalable, parallel, reacting-flow Direct Simulation Monte Carlo code for modeling nonequilibrium and collisional gas dynamic processes in complex geometries of interest to DoD. This manual is intended to document installation and operation of the SUPREM-DSMC package. This manual is presently under development. For the most part, only the required user-generated input files for the package are documented herein. Not all of the input variables documented at present will be available in all versions of the software.
DTIC
Monte Carlo Method; Gas Dynamics; Manuals; Computerized Simulation

20030061404 Air Force Research Lab. Edwards AFB CA
SUPREM-DSMC (CHSSI CFD-8)
Wysong, I. J.; Wadsworth, D. C.; Kaplan, C.; Mott, D.; Aug. 11, 2000; 56 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A411288; AFRL-PR-ED-TP-2000-162; No Copyright; Avail: CASI; A04, Hardcopy

Viewgraphs for presentation on the SUPREM-DSMC computer program; scalable, parallel, reacting, multidimensional direct simulation Monte Carlo flow code.
DTIC
Monte Carlo Method; Gas Dynamics; Computer Programs

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COMPUTER SYSTEMS

Includes computer networks and distributed processing systems. For information systems see *82 Documentation and Information Science*. For computer systems applied to specific applications, see the associated category.

20030059508 Instituto Nacional de Pesquisas Espacias, Sao Jose dos Campos, Brazil
Stateful Analysis of TCP/IP Network Traffic for Intrusion Detection Application
Chaves, Marcelo Henrique Peixoto Caetano; 2003; 162 pp.; In Portuguese
Report No.(s): INPE-9625-TDI/845; Copyright; Avail: CASI; A08, Hardcopy

In this work, the development of a session reconstruction methodology for TCP/IP network traffic is presented. The methodology is model based and uses network traffic extracted data for the reconstruction and tracking of sessions state using only packet headers. By extrapolating the concept of session this modeling allows not just the reconstruction and tracking of TCP sessions states, but also the reconstruction of ICMP and UDP sessions. The model has been designed to support the development of the TCP/IP Session's Reconstruction System - RECON - for use in intrusion detection. Since the state and packets history associated with a session can be used to decide if the traffic is part of an attack, differently from other methods that based decisions on a packet by packet exam, the use of this methodology can reduce the number of false-positives and false-negatives. It is also possible to correlate information from a set of sessions for the identification of hostile activities that can not be observed in an isolated session. The system makes use of a sensor that is appropriately located to capture packets from network traffic and to store captured data in files regularly. These files are transferred to an analysis station, where RECON runs. One feature of this methodology is the ability to treat a large amount of traffic, due to the use of a reduced amount of data associated with the packet headers. The developed system can also operate as a support tool, applied not just to intrusion detection but also to management, monitoring and testing of TCP/IP network traffic. Finally, the results obtained with the developed system are reported and showing the efficiency, capability and possible applications.
Author
Internets; Computer Information Security; Warning Systems; Packets (Communication)

20030060493 Stanford Univ., Stanford, CA
A Desktop Bulk Spin Computer
Harris, J. S.; Nov. 2002; 5 pp.; In English
Contract(s)/Grant(s): DAAG55-97-1-0341
Report No.(s): AD-A412753; ARO-37520.16-PH-QC; No Copyright; Avail: CASI; A01, Hardcopy

This project initiated on 8/1/97 with the goal of experimentally realizing small quantum computers using nuclear magnetic resonance (NMR) techniques, Our collaboration involved four groups with Stanford and IBM developing algorithms and numerical models, UC Berkeley synthesizing molecules and implementing algorithms at their high magnetic field NMR facility, and MIT investigating scaling to 100s of quantum bits and desktop size apparatuses. Our three principal aims were to: (1) Make quantum information processing feasible to transcend the classical limits in computation and communications (2) Take advantage of the inherent computational capability of physical systems using natural materials to eliminate the need for billion-dollar fabs, and (3) Integrate the physics, chemistry, electrical and mechanical engineering, computer science and mathematics needed to develop and deploy useful quantum information technology.
DTIC
Nuclear Magnetic Resonance; Mathematical Models; Quantum Computers; Algorithms; Computer Techniques

20030060589 NASA Marshall Space Flight Center, Huntsville, AL, USA
Use of Computed Tomography for Characterizing Materials Grown Terrestrially and in Microgravity
Gillies, Donald C.; Engel, H. Peter; 2002 Microgravity Materials Science Conference; February 2003, pp. 237-253; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

Computed Tomography (CT) has advanced considerably since being responsible for such dramatic advances in

diagnostics within the medical field. It has become a major tool in non destructive evaluation (NDE), and is used in many fields as diverse as coal-mining to metal solidification to examination of rock cores. A review of industrial applications has been written by Dennis. It is only recently that the technique has been seriously used to determine composition through precise measurement of density. While such applications are restricted to cases when there is no ambiguity in the relationship of composition to density. Thus alloy solid solutions lend themselves to compositional analysis provided there is a large change in density with composition. The technique is most useful when rapid non-destructive evaluation is needed. Such cases will occur with samples returning from the International Space Station (ISS) when knowledge of the results could affect future strategies for processing of on-board samples. Experiments from those Principal Investigators (PI) that are most likely to benefit from early CT scanning are discussed. With a dearth of samples, the major emphasis in the first part of this project has been on preparing suitable standards, optimizing the CT technique for these applications, and using the CT system to determine density variations with temperature. An interesting application of CT has been in the examination of meteorites, which can be classified as space-grown materials and will certainly have solidified in a low gravity environment.
Author
Nondestructive Tests; Diagnosis; Computer Aided Tomography

20030061089 Naval Postgraduate School, Monterey, CA
Emergency Response for Cyber Infrastructure Management
Dinolt, George W.; Irvine, Cynthia E.; Levin, Timothy E.; Feb. 2003; 9 pp.; In English
Report No.(s): AD-A412733; NPS-CS-03-005; No Copyright; Avail: CASI; A02, Hardcopy

The objective of this research is to investigate architectural mechanisms to provide an emergency response capability for Cyber Infrastructure management through the use of distributed, highly secure, protected domains. Instead of creating a costly physically separate cyber domain, logical separation is used. This work developed an architecture and prototype demonstration in the context of an open source operating system.
DTIC
Architecture (Computers); Civil Defense

20030061091 Naval Postgraduate School, Monterey, CA
Policy Enforced Remote Login
Nguyen, Thuy D.; Levin, Timothy E.; Feb. 2003; 11 pp.; In English
Report No.(s): AD-A412735; NPS-CS-03-004; No Copyright; Avail: CASI; A03, Hardcopy

This document describes enhancements made to the popular OpenSSH authentication service to restrict the execution of OpenSSH processes by applying a ring-based program execution policy. We also apply a label-based mandatory access control (MAC) policy to limit a user's login shell to run at a specific security level within the user's authorized security clearance range. While still rudimentary, these enhancements illustrate the usefulness of a ring-based execution mechanism for restricting program behavior.
DTIC
Access Control; Computer Security

20030061095 Bologna Univ., Italy
FOSAD 2001: 2nd International School on Foundations of Security Analysis and Design
Jan. 2001; 292 pp.; In English
Contract(s)/Grant(s): N00014-01-1-10XX
Report No.(s): AD-A410830; No Copyright; Avail: CASI; A13, Hardcopy

Security in computer systems and networks is emerging as one of the most challenging research areas for the future. The main aim of the school is to offer a good spectrum of current research in foundations of security, ranging from programming languages to analysis of protocols, that can be of help for graduate students, young researchers from academia or industry that intend to approach the field, The school covers two weeks (from Monday 17 to Saturday 29, September 2001) and alternates four lecturers per week.
DTIC
Computer Networks; Computer Systems Design; Computer Information Security; Education

20030061135 Coventry Univ., Coventry, UK
A Mobile Agent Framework for Telecardiology
Chao, K. M.; Anane, R.; Plumley, J.; Godwin, N.; Naguib, R. N. G.; October 25, 2001; 5 pp.; In English
Report No.(s): AD-A411119; No Copyright; Avail: CASI; A01, Hardcopy

It is generally recognized that telecommunications and the internet in particular are changing the way health care is delivered in cardiology. Current implementations of telecardiology are often characterized by a centralized approach. Within this set-up a central system is connected to various remote sites. The central system has to keep track of the activities and of the state of these sites through constant communication with them. This scheme requires large volumes of data, particularly in the case of electrocardiograms (ECGs), to be generated in the remote sites and then to be transmitted to a central control system. This often leads to bottlenecks in communication that may adversely affect the quality of care. In this paper we propose a decentralized approach based on a combination of mobile agents (MA) and an Object Request Broker (ORB) mechanism. Its main aim is to support interoperability and to optimize the monitoring processes by reducing unnecessary communication. MAs possess a degree of autonomy that enables them to filter data on the remote site, and thus ease the load on the central monitoring system. They have the added advantage that they can be customized to meet individual needs. The ORB mechanism is incorporated in order to increase the reliability of MAs and to facilitate the integration of various ECG analysis software systems available on the market. It is expected that the proposed system will provide a framework for improved monitoring of patients and will lead therefore to better health care in cardiology.
DTIC
Electrocardiography; Telemedicine; Data Transmission; Cardiology

20030061160 TRW Inc Killeen TX
A Nationwide Experimental Multi-Gigabit Network
Reddy, Raj; Mar. 2003; 127 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F30602-98-2-0193; DARPA ORDER-G147; Proj-G147
Report No.(s): AD-A412875; AFRL-IF-RS-TR-2003-55; No Copyright; Avail: CASI; A07, Hardcopy

The High Speed Connectivity Consortium (HSCC) created a nation-wide multi-gigabit network, capable of gigabit connections to end user sites, using fiber optic links at OC-48 rates. The consortium provided high-speed access to the network with consumption-based pricing for affordability. The network backbone was provided by Qwest using their national network. Local access was provided by various sources such as power utilities, Competitive local exchange carriers, and other Right-of-Way owners. The network provided high speed connectivity for research in networking architectures, high bandwidth applications, and protocol research. Specifically, the Matisee Project, a joint collaboration between UC berkeley, LBNL, CMU, MIT, CNRI and USC/ISI utilized the network for remote MEMS design, fabrication and testing/experiments. The network enabled research into why host systems and the TCP protocols have so much difficulty achieving high performance when operating across high bandwidth delay product networks. The network also enabled research and testing into the distribution of Uncompressed HTDV across wide area networks.
DTIC
Fabrication; Fiber Optics; Computer Networks; Architecture (Computers); Wide Area Networks

63
CYBERNETICS, ARTIFICIAL INTELLIGENCE AND ROBOTICS

Includes feedback and control theory, information theory, machine learning, and expert systems. For related information see also *54 Man/System Technology and Life Support*.

20030059511 Institute for Scientific Research, Fairmont, WV, USA
The Intelligent Flight Control Program (IFCS)
March 31, 2003; 4 pp.; In English
Contract(s)/Grant(s): NCC4-00128; No Copyright; Avail: CASI; A01, Hardcopy

Institute for Scientific Research, Inc. (ISR) is pleased to submit this closeout report for the Research Cooperative Agreement NCC4-00128 of accomplishments for the Intelligent Flight Control System (IFCS) Project. It has been a pleasure working with NASA and NASA partners as we strive to meet the goals of this research initiative. ISR was engaged in this Research Cooperative Agreement beginning March 3, 2001 and ending March 31, 2003. During this time, a great deal has been accomplished and plans have been solidified for the continued success of this program. Our primary areas of involvement include the following: 1) ARTS II Master Test Plan; 2) ARTS II Hardware Design and Development; 3) ARTS II Software Design and Development; 4) IFCS PID/BLNN/OLNN Development; 5) Performed Preliminary and Formal Testing; 6) Documentation and Reporting.
Author
Automatic Flight Control; Artificial Intelligence; Research And Development

20030059514 Tsinghua Univ., Bejing, China

Text-Independent Speaker Identification by Genetic Clustering Radial Basis Function Neural Network

Yue, Xicai; Ye, Datian; Liu, Ming; Oct. 25, 2001; 5 pp.; In English

Report No.(s): AD-A412429; No Copyright; Avail: CASI; A01, Hardcopy

The authors combine genetic clustering algorithm with radial basis function neural network (RBFNN) for avoiding locally optimum solutions in speaker identification. The effectiveness of genetic clustering algorithm is evaluated with speech utterances by comparing with normal clustering method. Speaker identification experiments show that generic clustering RBFNN can improve the correctness of text-independent speaker identification.

DTIC

Cluster Analysis; Speech Recognition; Genetic Algorithms

20030060440 Canterbury Univ., Christchurch, New Zealand

Modeling Human Open-Loop Tracking Behavior

Davidson, Paul R.; Jones, Richard D.; Andreae, John H.; Sirisena, Harsha R.; Oct. 25, 2001; 5 pp.; In English

Report No.(s): AD-A412110; No Copyright; Avail: CASI; A01, Hardcopy

A nonlinear generalization of the Adaptive Model Theory, nAMT, is compared with human open-loop tracking data across the same range of conditions. The resulting simulations produced effects that mirrored the closed- and open-loop characteristics of the experimental response trajectories. This supports the use of an internal feedback loop for the inversion of external systems in the nAMT model. Other control-systems models (both AMT and feedback-error learning) were unable to reproduce the observed disparity between closed- and open-loop results without fundamental modification. A low internal feedback loop-gain, incorporating a substantial derivative component, caused this effect. This low gain produced acceptable performance due to the relatively low target bandwidth used in the study, allowing the feedback control component to function. Maintenance of the loop-gain at the lowest possible levels is thought to maximize the internal stability of the inverse. The simulation work confirmed that the nAMT model is capable of reproducing human behavior under a wide range of conditions.

DTIC

Feedback Control; Nonlinearity; Mathematical Models; Adaptive Control; Human Behavior; Tracking (Position)

20030060646 Tohoku Univ., Sendai, Japan

Recognition of Lower Limb Movements by Artificial Neural Network for Restoring Gait of Hemiplegic Patients by Functional Electrical Stimulation

Watanabe, T.; Yamagishi, S.; Murakami, H.; Furuse, N.; Hoshimiya, N.; Oct. 25, 2001; 5 pp.; In English

Report No.(s): AD-A412256; No Copyright; Avail: CASI; A01, Hardcopy

This study focused on the man-machine interface of functional electrical stimulation (FES) systems for restoring the gait of hemiplegic patients. A method of recognition of lower limb movements using an artificial neural network (ANN) was examined in monitoring restored motions and in giving control command with 5 neurologically intact males, 22 to 24 years of age, and a female hemiplegic patient who was 55 years old. Acceleration signals were measured with a three-axis accelerometer attached to the heel of the normal side (right side) during walking. Subjects performed specific movements with their normal lower limbs supposing control command input in the walking measurements. The ANN recognized three different walking patterns: level floor walking, going up stairs, and going down stairs. Recognition was based on acceleration waveforms with an 80\% recognition rate for normal subjects and above 70\% for the patient. A similar structure of the ANN discriminated four specific movements by the lower extremity with a more than 90\% recognition rate after the third performance of the movement simulated by using recognition and misrecognition rates for experimentally measured data. The method was found to be useful in monitoring FES movements and in giving control commands to the FES system without using upper limbs. The technique is expected to provide information for assuring the safety of patients and to improve operationality of the FES system for practical use. (3 tables, 3 figures, 3 refs.)

DTIC

Neural Nets; Walking; Stimulation

20030061178 Massachusetts Inst. of Tech., Cambridge, MA

Design and Control of a Nonlinearly Compliant Robotic Finger

Shah, Vinay K.; Sep. 1997; 110 pp.; In English

Contract(s)/Grant(s): N00014-97-1-0698

Report No.(s): AD-A412868; No Copyright; Avail: CASI; A06, Hardcopy

This report describes an inexpensive, modular robot finger utilizing exponentially stiffening springs between the actuators and joints. Controlling the deflection of these springs is equivalent to controlling force, since the deflection is directly related to the applied force through the spring's force-deflection curve. Therefore, the use of compliance in the joints transforms the problem of force control into one of position control, thereby simplifying force control algorithms, improving performance and allowing the use of small, cheap, gear-reduced actuators. The exponential nature of the compliance allows a constant percentage resolution of forces that can be exerted and sensed. This constant percentage resolution leads to an extremely large dynamic range and excellent contact sensing ability. These traits are also present in humans, and have been identified as essential to the dexterity of human fingers. The fingers can be used in combination to form a hand capable of grasping and grasp gaits, or individually for palpation and perception.
DTIC
Robotics; Nonlinearity; End Effectors; Control Systems Design

20030061318 Bilkent Univ., Ankara, Turkey
Biopotential Instrumentation Set
Yildiz, Metin; Guler, F. N.; Turkmen, Ahmet; Yilmaz, Derya; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A410738; No Copyright; Avail: CASI; A01, Hardcopy

In this study, a biological signal acquisition and processing set has been designed and realized. The set can be used in teaching basic principles in recording and analyzing of biological signals. This set can be used in biomedical electronics engineering and biomedical technology laboratories. The set is especially helpful to teach how the biological signals are acquired and processed. ECG and EMG signals can be selected, amplified, filtered and transferred to the monitoring devices with this set while patient safety is provided. There are a number of connection points in the set for observing the signals at various levels. Students can make measurements at each of these steps with the connection probes outside the set. The output signals can be observed using an oscilloscope. They can also be observed from a PC monitor with an electronic card connected to ISA bus.
DTIC
Signal Processing; Bioelectric Potential

20030061358 International Turkmen Turkish Univ., Ashgabat, Turkey
A Fuzzy Rule-Base Model for Classification of Spirometric FVC Graphs in Chronical Obstructive Pulmonary Diseases
Uncu, Umit; Koklukaya, Etam; Gencsoy, Aydin; Annadurdiyew, Ovlyaguli; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411170; No Copyright; Avail: CASI; A01, Hardcopy

In diagnosis of COPD (Chronic Obstructive Pulmonary Diseases), spirometry is an important 'Pulmonary Function Testing' in the medical evaluation of patients. Spirometric measurements FVC & FEV1 are very important to control the treatment, but some difficulties such as incompleteness, inaccuracy and inconsistency are encountered during the test. 'Fuzziness in Spirometry' is very important 'real-world problem'. Even if it is almost impossible to find ideal mathematical equations, ideal prediction formulas and ideal propositions defining the behaviors formulated ideally satisfying the real-life, it is possible to define inexact medical information and findings as fuzzy sets. Furthermore, because of collected data just lying on the border-line cannot be strictly or clearly defined either 'normal' or 'abnormal', the physicians may misinterpret some criteria or indications. For such kind of reasons, it is needed a formal model of distinguishing COPD group diseases (chronic bronchitis, emphysema and asthma) by using fuzzy theory and to put into practice a 'fuzzy rule-base'. Purpose of this study is to construct a fuzzy rule-base model for designing a 'COPD Diagnosing Fuzzy Expert System by Classifying Spirometric FVC Plots'
DTIC
Artificial Intelligence; Fuzzy Systems; Pulmonary Functions; Diseases

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NUMERICAL ANALYSIS

Includes iteration, differential and difference equations, and numerical approximation.

20030059512 National Defence Academy, Yokosuka, Japan
Time-Frequency Analysis of a Noisy Ultrasound Doppler Signal With a 2nd Figure Eight Kernel
Noguchi, Yasuaki; Kashiwagi, Eiichi; Watanabe, Kohtaro; Matsumoto, Fujihiko; Sugimoto, Suguru; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A412427; No Copyright; Avail: CASI; A01, Hardcopy

Nonstationary ultrasound Doppler signals, those are changing with time and frequency simultaneously, are widely observed in biological and speech signals. A Cohen's class time-frequency (TF) analysis can analyze nonstationary signals with high resolution in time and frequency at a same time. A time-frequency distribution (TFD) is largely affected by a kernel function. Thus, there is sometimes a case where auto-terms (those are signal components) are covered by cross-terms (those are spurious components). In order to apply TFDs to a nonstationary and nonlinear Doppler ultrasound signals, experimental data were obtained by moving a steel ball to and fro by continuously irradiating it with ultrasound in olive oil. The movement of the steel ball was controlled by various functions. To analyze these signals, four kernels were used: (1) a Wigner kernel, (2) a Choi-Williams kernel, (3) a figure eight kernel, and (4) a 2nd figure eight kernel. Using our 2nd figure eight kernel, the demodulation accuracy was improved even with noise.
DTIC
Signal Processing; Kernel Functions

20030060516 Cornell Univ., Ithaca, NY, USA
Melt Flow Control in the Directional Solidification of Binary Alloys
Zabaras, Nicholas; 2002 Microgravity Materials Science Conference; February 2003, pp. 695-706; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NRA-98-HEDS-05; No Copyright; Avail: CASI; A03, Hardcopy

Our main project objectives are to develop computational techniques based on inverse problem theory that can be used to design directional solidification processes that lead to desired temperature gradient and growth conditions at the freezing front at various levels of gravity. It is known that control of these conditions plays a significant role in the selection of the form and scale of the obtained solidification microstructures. Emphasis is given on the control of the effects of various melt flow mechanisms on the local to the solidification front conditions. The thermal boundary conditions (furnace design) as well as the magnitude and direction of an externally applied magnetic field are the main design variables. We will highlight computational design models for sharp front solidification models and briefly discuss work in progress toward the development of design techniques for multi-phase volume-averaging based solidification models.
Author
Directional Solidification (Crystals); Fluid Flow; Design Analysis; Temperature Gradients; Gravitation; Furnaces

20030060561 NASA Johnson Space Center, Houston, TX, USA
Monte Carlo Methods in Materials Science Based on FLUKA and ROOT
Pinsky, Lawrence; Wilson, Thomas; Empl, Anton; Andersen, Victor; 2002 Microgravity Materials Science Conference; February 2003, pp. 441-451; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A03, Hardcopy

A comprehensive understanding of mitigation measures for space radiation protection necessarily involves the relevant fields of nuclear physics and particle transport modeling. One method of modeling the interaction of radiation traversing matter is Monte Carlo analysis, a subject that has been evolving since the very advent of nuclear reactors and particle accelerators in experimental physics. Countermeasures for radiation protection from neutrons near nuclear reactors, for example, were an early application and Monte Carlo methods were quickly adapted to this general field of investigation. The project discussed here is concerned with taking the latest tools and technology in Monte Carlo analysis and adapting them to space applications such as radiation shielding design for spacecraft, as well as investigating how next-generation Monte Carlos can complement the existing analytical methods currently used by NASA. We have chosen to employ the Monte Carlo program known as FLUKA (A legacy acronym based on the German for FLUctuating KAscade) used to simulate all of the particle transport, and the CERN developed graphical-interface object-oriented analysis software called ROOT. One aspect of space radiation analysis for which the Monte Carlo s are particularly suited is the study of secondary radiation produced as

albedoes in the vicinity of the structural geometry involved. This broad goal of simulating space radiation transport through the relevant materials employing the FLUKA code necessarily requires the addition of the capability to simulate all heavy-ion interactions from 10 MeV/A up to the highest conceivable energies. For all energies above 3 GeV/A the Dual Parton Model (DPM) is currently used, although the possible improvement of the DPMJET event generator for energies 3-30 GeV/A is being considered. One of the major tasks still facing us is the provision for heavy ion interactions below 3 GeV/A. The ROOT interface is being developed in conjunction with the CERN ALICE (A Large Ion Collisions Experiment) software team through an adaptation of their existing AliROOT (ALICE Using ROOT) architecture. In order to check our progress against actual data, we have chosen to simulate the ATIC14 (Advanced Thin Ionization Calorimeter) cosmic-ray astrophysics balloon payload as well as neutron fluences in the Mir spacecraft. This paper contains a summary of status of this project, and a roadmap to its successful completion.
Author
Applications Programs (Computers); Monte Carlo Method; Cosmic Rays; Extraterrestrial Radiation; Cosmic Ray Albedo; Particle Interactions

20030060595 Duke Univ., Durham, NC
Shape and Surface Reconstruction, Quantification and Deformation
Edelsbrunner, Herbert; Fu, Ping; Jan. 8, 2003; 5 pp.; In English
Contract(s)/Grant(s): DAAG55-98-1-0177
Report No.(s): AD-A412896; ARO-37578.12-MA; No Copyright; Avail: CASI; A01, Hardcopy
Research under this grant focused on the reconstruction and the representation of continuous shapes and objects. The primary data structure are meshes, and we study triangle meshes for surface and tetrahedron meshes for volume data. Beyond these two types, we obtained new results for constructing quadrangular meshes for surfaces. Our approach to these problems was fairly broad, ranging from problem modeling, to algorithm design, to implementing and experimenting, and to application finding and adaptation.
DTIC
Deformation; Shapes; Applications Of Mathematics

20030060699 Huddersfield Univ., Huddersfield, UK
Algorithms For Approximation IV. Proceedings of the 2001 International Symposium
Levesley, Jeremy; Anderson, Iain; Mason, John C.; Jan. 2002; 493 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F61775-00-WF078
Report No.(s): AD-A412833; EOARD-CSP-00-5078; No Copyright; Avail: CASI; A21, Hardcopy
The Final Proceedings for Algorithms for Approximation IV (A4A4), 16 July 2001-20 July 2001, a multidisciplinary conference addressing many areas of interest to the Air Force. Of primary interest are the potential applications to Modeling and Simulation. Specifically, the topics to be covered include in the following four major areas: Algorithms, Efficiency, Software, and Applications. Each major topic is divided into subtopics as follows: Algorithms- Approximation of Functions, Data Fitting, Geometric and Surface Modelling, Splines, Wavelets, Radial Basis Functions, Support Vector Machines, Norms and Metrics, Errors in Data, Uncertainty Estimation; Efficiency- Numerical Analysis, Parallel Processing; Software- Standards, Libraries, New Routines, World Wide Web; Applications- Metrology (Science of Measurement), Data Fusion, Neural Networks and Intelligent Systems, Spherical Data and Geodetics, Medical Data.
DTIC
Algorithms; Numerical Analysis; Conferences; Approximation

20030061127 Cukurova Univ., Adana, Turkey
Assessment of Gaussian Radial Basis Function Network on Protein Secondary Structures
Ibrikci, T.; Guler, M.; Acikkar, M.; Oct. 25, 2001; 4 pp.; In English
Report No.(s): AD-A410939; No Copyright; Avail: CASI; A01, Hardcopy
Studies of the radial basis function (RBF) network on protein secondary structures are presented. Secondary structure prediction is a useful first step in understanding how the amino acid sequence of protein determines the native state. If the secondary structure is known, it is possible to derive a comparatively small number of tertiary structures using the secondary structural element pack. A study of the Gaussian-RBF with different window sizes on the dataset developed by Qian-Sejnowski, and also a dissimilar dataset by Chandonia is given. The RBF network predicts each position in turn based on a local window of residues, by sliding this window along the length of the sequence. It is shown that the Gaussian RBF

network is not an appropriate technique to be used in the prediction of secondary structure for sequence structural state.
DTIC
Proteins; Numerical Analysis; Normal Density Functions; Molecular Structure

20030061270 Kobe Univ., Japan
Autocorrelation and Cross-Correlation Analyses of Alpha Waves in Reflection to Subjective Preference of a Flickering Light
Soeta, Y.; Uetani, S.; Ando, Y.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A412194; No Copyright; Avail: CASI; A01, Hardcopy

To clarify the relationship between the human brain activity and subjective preference of a flickering light under changing temporal frequency and mean luminance, alpha waves were analyzed by autocorrelation function (ACF) and cross correlation function (CCF). Paired-comparison tests were performed to examine the subjective preference of a flickering light. Electroencephalograms (EEGs) were recorded from 7 electrodes (10-20 system) during presentations of the most preferred and the least preferred flickering-light conditions. From the initial delay range of the ACF, the effective duration was determined to describe the temporal characteristics of the alpha waves. Results show that the preferred flickering light has a significant larger tau(sub e) than that of the least preferred flickering light especially at the occipital area.
DTIC
Brain; Autocorrelation; Cross Correlation; Electroencephalography

20030061276 Engineering Research and Consulting Inc (ERC Inc) Edwards AFB CA, Edwards AFB, CA, USA
Fracture Parameter Calculations for SENT Specimens with Two Boundary Conditions
Baron, D. T.; 4 May 1999; 6 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A412837; AFRL-PR-ED-TP-FY99-0072; No Copyright; Avail: CASI; A02, Hardcopy

This paper is about finite element calculations of the Mode 1 stress intensity factor (K(sub 1)), and the T-stress (T),for single edge-notched tension (SENT) specimen 5. Linear elastic fracture mechanics (LEFM) is used. 4 cases of traction application method and plane state (TAMPS) are considered, applied uniform load and plane stress (LS), applied uniform load and plane strain (LN), applied uniform displacement and plane stress (DS), applied uniform displacement and plane strain (DN). For all cases, the material is considered to be incompressible, i.e., 0.5 is used for Poisson's ratio (v). Young's modulus is referred to as E. The total height (perpendicular to the crack) of a SENT specimen is called h, and the total width (parallel to the crack) is called w. The crack length is called a.
DTIC
Stress Intensity Factors; Independent Variables; Finite Element Method; Fracture Mechanics

20030061372 Gaziantep Univ., Turkey
Comparison of FFT, AR and Wavelet Methods in Transcranial Doppler Signal Obtained From Intracerebral Vessels
Gueler, I.; Hardalac, F.; Erol, F. S.; Oct. 25, 2001; 3 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411222; No Copyright; Avail: CASI; A01, Hardcopy

In this work, transcranial Doppler signals recorded from the temporal region of brain on 35 patients were transferred to a personal computer (PC) via 16 bit sound card. FFT, AR and WT methods were applied to transcranial Doppler for obtaining sonograms. Spectral analysis were obtained in order to compare with three methods in the case of medical diagnosis. The comparison shows that WT method offers better results for the spectral resolution than the other methods. This also leads the determination of brain pressure more accurately.
DTIC
Brain; Fast Fourier Transformations; Wavelet Analysis; Blood Vessels; Spectrum Analysis

20030061379 Valladolid Univ., Spain
Multiresolution Compression Schemes for Medical Image and Volume Data
Martin, Miguel A.; Alberola, Carlos; Sanz de Acedo, Jorge; Ruiz-Alzola, Juan; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A411461; No Copyright; Avail: CASI; A01, Hardcopy

In this paper we propose a multiresolution compression scheme applied to image and volume data. It is intended for rapid browsing in graphical files, in which some regions of interest may exist; therefore the compression algorithms focus on incorporating quick full-reconstruction procedures, both in images and volumes. This scheme is based on vector quantization

of the coefficients of a wavelet decomposition. The differences in the methods lie on how vectors in the multiresolution decompositions are selected for vector quantization. We have also developed a client-server application using this scheme, which allows images with increasing levels of detail to be represented in the client system, as they are received from the server and decoded. Numerical results show the performances of all the selections made.
DTIC
Data Compression; Image Reconstruction

20030061380 Cankaya Univ., Ankara, Turkey
An Approach to Noise Reduction in Human Skin Admittance Measurements
Kondakci, Suleyman; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411898; No Copyright; Avail: CASI; A01, Hardcopy

This paper presents the development of a signal averaging algorithm for recovering excitation responses contaminated by overwhelming amount of various types of interference in skin admittance measurements. The algorithm is designed to eliminate Gaussian-distributed noise by use of a recursive approach. The process of recovering low magnitude voltage responses from highly noise-contaminated waveforms is a CPU-intensive task. In real-time measurements, iterative reconstruction algorithm is inefficient and time consuming when slow varying input waveforms are present. To increase the quality of the reconstruction a considerably large number of recursions is required. Increasing the number of recursions is appropriate for batch processing of measurement data. However, the algorithm considers measurements in real-time, whereas required quality, of signal reconstruction should be kept independent from the number of recursions.
DTIC
Noise Reduction; Iir Filters

20030061384 SHANDONG UNIV JINAN (CHINA)
EEG Multiresolution Analysis Using Wavelet Transform
Weidong, Zhou; Yingyuan, Li; Oct. 25, 2001; 4 pp.; In English
Report No.(s): AD-A411450; No Copyright; Avail: CASI; A01, Hardcopy

Wavelet transform (WT) is a new multiresolution time-frequency analysis method. WT possesses well localization feature both in tine and frequency domains. it acts as a group of band-pass filters to decompose mixed signal into signals at different frequency bands. EEG as a noninvasive testing method plays a key role in the diagnosing diseases and is useful for both physiological research and medical applications. Using the dyadic wavelet transform the EEG signals are successfully decomposed to the alpha rhythm (8-13Hz) beta rhythm (14-30Hz) theta rhythm (4-7Hz) and delta rhythm (0.3-3Hz) and the EMG trembles in EEG are effectively removed while the useful information of EEG are well reserved so as to improve SNR. The experiment results are given in the end of the paper.
DTIC
Signal Processing; Electroencephalography; Wavelet Analysis

20030061392 Tehran Univ., Tehran, Iran (Islamic Republic of)
Automatic Grading of Pathological Images of Prostate Using Multiwavelet Transform
Khouzani, Kourosh J.; Soltanian-Zadeh, Hamid; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A410854; No Copyright; Avail: CASI; A01, Hardcopy

Manual histological grading of pathological tissue is a task done by pathologists to determine the level of malignancy of cancerous tissues. However, manual grading is inconsistent due to variations in a pathologist's judgments day to day and variations in judgment from pathologist to pathologist. This paper presents a new method for automatic grading of pathological images of the prostate based on the Gleason grading system. Gleason grading from very well differentiated (grade 1) to very poorly differentiated (grade 5) is usually done by viewing the low magnification microscopic image of the cancer. The lower the Gleason score, the better the patient is likely to do. According to this automated system, each cancerous specimen is assigned one of five grades based on features extracted from the multiwavelet transform of images. Specifically, energy and entropy features are extracted from submatrices obtained in decomposition, then a k-NN classifier is used to classify each image. The authors also used features extracted by wavelet packet decomposition (Daubechies wavelet D6 and D20) and second order moments to see how they compared with multiwavelet transform. The leaving-one-out technique was used to estimate error rate. One hundred graded prostate tissue sample images were processed by the automated approach. The results show the superiority of multiwavelet transform for grading compared with the other techniques. The first level of decomposition was very sensitive to noise and should not be used for feature extraction. In terms of second-level

decomposition, critically sampled preprocessing was less sensitive to noise than repeated row preprocessing. The authors conclude that better classification can be achieved using second and higher levels of decompositions, while selecting the best features for classification.
DTIC
Histology; Prostate Gland; Pathology; Automatic Control; Wavelet Analysis

20030061395 Isik Univ., Istanbul, Turkey
A Novel Method to Represent ECG Signals Via Predefined Personalized Signature and Envelope Functions
Yarman, B. S.; Gurkan, H.; Guz, U.; Aygun, B.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411176; No Copyright; Avail: CASI; A01, Hardcopy

In this paper, a new method to model ECG signals by means of 'Predefined Personalized Signature and Envelope Functions' is presented. ECG signals are somewhat unique to a person. Moreover, it presents quasi-stationary behavior. Therefore in this work, on a frame basis, personal ECG signals X(sub i)(t) is modeled by the form of X(sub i)(t) = C(sub i)phi(sub i)(t) alpha(sub i)(t). In this model, phi(sub i)(t) is defined as the Personalized Signature Function (PSF); alpha(sub i)(t) is referred to as Personalized Envelope Function (PEF) and C(sub i) is called the Frame-Scaling Coefficient (FSC). It has been demonstrated that for each person, the sets Phi=?phi(sub k)(t)! and Alpha=?alpha(sub r)(t)! constitute a 'Predefined Personalized Functional Bases or Banks (PPFB)' to describe any measured ECG signal. Almost optimum forms of (PPFB), namely ?alpha(sub r)(t)!, ?phi(sub k)(t)! pairs are generated in the Least Mean Square (LMS) sense. Thus, ECG signal for each frame is described in terms of the two indices 'R' and 'K' of PPFB and the frame-scaling coefficient C(sub i). It has been shown that the new method of modeling provides significant data compression. Furthermore, once PPFB are stored on each communication node, transmission of ECG signals reduces to the transmission of indexes 'R' and 'K' of ALPHA(SUB R)(T), PHI(SUB K)(T) pairs and the coefficients C(sub i), which also result in considerable saving in the transmission band.
DTIC
Electrocardiography; Signal Processing; Data Compression; Mathematical Models

65
STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; time series analysis; and stochastic processes.

20030060491 Dundee Univ., UK
Defect Characterization of Pyroelectric Materials
Keeble, David J.; Nov. 2002; 29 pp.; In English
Contract(s)/Grant(s): N68171-99-M-6463
Report No.(s): AD-A411961; R/D-8828-EE-01; No Copyright; Avail: CASI; A03, Hardcopy

Two methods for identify point defects applicable to the study of technologically relevant pyroelectric oxide materials have been investigated, namely Positron Annihilation Lifetime Spectroscopy (PALS) and Electron Paramagnetic Resonance (EPR). For this study a PALS spectrometer was constructed. Preliminary PALS and EPR results on powder and ceramic materials are presented. An operational positron annihilation lifetime spectrometer has been constructed and tested. The resolution function width of approximately 205 ps with a count rate of 130 counts S(-1) from a 370 kBq(-1) source was achieved. Two independent analysis algorithms were tested using simulated lifetime spectra. Systematic studies were performed on a series of polycrystalline pure metal samples. This work confirmed the need for accurate source annihilation correction and allowed a methodology to be developed. Further, this procedure allowed the variation in backscatter source contribution with atomic number to be studied. The spectrometer was then used to study two pyroelectric Pb based perovskite oxide ceramic samples, a La doped PZT sample, (Pb,La)(Zr,Ti)O3, and an undoped Pb(Sc(0.5), Ta(0.5))O3 (PST) sample. Fits using maximum entropy method and source corrected fitting using non-linear least square where found to be similar. A second vacancy defect contribution was clearly observed in both samples. Electron paramagnetic resonance measurements were extended from earlier single crystal PbTiO3 work to powder Pb(Zr,Ti)O3 samples. A series of Mn doped samples was studied. The spectrum was found to contain contributions from both Mn(4+) and Mn(2+) charge states.
DTIC
Ferroelectric Materials; Pyroelectricity; Point Defects; Spectrometers; Algorithms

20030060579 Tennessee Univ., TN, USA

Development of A Monte Carlo Radiation Transport Code System For HEDS: Status Update

Townsend, Lawrence W.; Gabriel, Tony A.; Miller, Thomas M.; 2002 Microgravity Materials Science Conference; February 2003, pp. 623-630; In English; See also 20030060494; Original contains color illustrations

Contract(s)/Grant(s): NAG8-1669; No Copyright; Avail: CASI; A02, Hardcopy

Modifications of the Monte Carlo radiation transport code HETC are underway to extend the code to include transport of energetic heavy ions, such as are found in the galactic cosmic ray spectrum in space. The new HETC code will be available for use in radiation shielding applications associated with missions, such as the proposed manned mission to Mars. In this work the current status of code modification is described. Methods used to develop the required nuclear reaction models, including total, elastic and nuclear breakup processes, and their associated databases are also presented. Finally, plans for future work on the extended HETC code system and for its validation are described.

Author

Galactic Cosmic Rays; Monte Carlo Method; Radiation Transport; Computer Programs; Extraterrestrial Radiation

20030060662 BBNT Solutions, LLC, Cambridge, MA, USA

Cyber Panel Experimentation Program

Haines, Joshua; Ryder, Dorene K.; Tinnel, Laura; Taylor, Stephen; Mar. 2003; 32 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): F30602-02-C-0106; Proj-N176

Report No.(s): AD-A412507; AFRL-IF-RS-TR-2003-45; No Copyright; Avail: CASI; A03, Hardcopy

This CyberPanel Experimentation Program final report describes two experiments: (1) an experimental validation of correlation systems as well as (2) a validation of autonomic response systems. The goal of this effort was to assess the overall progress in the field by separately measuring the aggregate correlation efficacy and response capabilities of seven distinct research technologies. The network supported planning activities critical to a hypothetical military mission and supported modeled user activity such as email and web browsing. Each enclave was defended by security devices implementing a defined security policy and by various intrusion detection sensors. A variety of multi-step cyber attacks were perpetrated against the target network each of which typifies a current-day real-world attack. The preliminary results presented here represent those available at conclusion of the experiment process by BBN.

DTIC

Correlation; Intrusion Detection (Computers)

20030061132 Engineering Research and Consulting Inc (ERC Inc) Edwards AFB CA, Edwards AFB, CA, USA

DSMC Study of Flowfield and Kinetic Effects on Vibrational Excitations in Jet-Freestream Interactions

Campbell, David H.; Wysong, Ingrid J.; Jun. 21, 2002; 12 pp.; In English

Contract(s)/Grant(s): Proj-2308

Report No.(s): AD-A410980; AFRL/PRS-ED-TP-2002-163; No Copyright; Avail: CASI; A03, Hardcopy

The Direct Simulation Monte Carlo (DSMC) computational technique was used to simulate the interaction between a carbon monoxide jet and a high velocity free stream of oxygen atoms oriented at 90 degrees to the jet flow axis at 150 kilometers simulated altitude. The results of a study to characterize the sensitivity of predicted carbon monoxide vibrational excitation to the vibrational excitation cross section and the nozzle exit plane profile are presented in this paper. A literature value of the vibrational excitation cross section is used as a baseline, and comparative simulations are made for cross sections that vary around that value. Similarly, the nozzle exit plane profile is varied from a 'flat' profile to a fully developed laminar boundary layer profile to obtain sensitivities to the jet inflow startline. xSMlLE, a software system based on the DSMC method, developed at the Institute of Theoretical and Applied Mechanics, Novosibirsk, Russia, has been utilized for this study. The results demonstrate a generally linear scaling of the vibrational excitation with cross section, except for cross sections that produce excitation rates in excess of the VHS gas kinetic rate. The jet exit-plane boundary layer profile was found to be a factor in the amount of carbon monoxide excited state produced in the interaction region.

DTIC

Computerized Simulation; Excitation; Jet Flow; Monte Carlo Method; Vibration; Flow Distribution; Kinetics; Free Flow

20030061221 NASA Marshall Space Flight Center, Huntsville, AL, USA

Statistical Properties of Maximum Likelihood Estimators of Power Law Spectra Information

Howell, L. W., Jr.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

A simple power law model consisting of a single spectral index, sigma(sub 2), is believed to be an adequate description of the galactic cosmic-ray (GCR) proton flux at energies below 10(exp 13) eV, with a transition at the knee energy, E(sub k), to a steeper spectral index sigma(sub 2) greater than sigma(sub 1) above E(sub k). The maximum likelihood (ML) procedure was developed for estimating the single parameter sigma(sub 1) of a simple power law energy spectrum and generalized to estimate the three spectral parameters of the broken power law energy spectrum from simulated detector responses and real cosmic-ray data. The statistical properties of the ML estimator were investigated and shown to have the three desirable properties: (Pl) consistency (asymptotically unbiased), (P2) efficiency (asymptotically attains the Cramer-Rao minimum variance bound), and (P3) asymptotically normally distributed, under a wide range of potential detector response functions. Attainment of these properties necessarily implies that the ML estimation procedure provides the best unbiased estimator possible. While simulation studies can easily determine if a given estimation procedure provides an unbiased estimate of the spectra information, and whether or not the estimator is approximately normally distributed, attainment of the Cramer-Rao bound (CRB) can only be ascertained by calculating the CRB for an assumed energy spectrum- detector response function combination, which can be quite formidable in practice. However, the effort in calculating the CRB is very worthwhile because it provides the necessary means to compare the efficiency of competing estimation techniques and, furthermore, provides a stopping rule in the search for the best unbiased estimator. Consequently, the CRB for both the simple and broken power law energy spectra are derived herein and the conditions under which they are stained in practice are investigated.
Author
Maximum Likelihood Estimates; Power Spectra; Statistical Distributions; Mathematical Models; Galactic Cosmic Rays

20030061268 Massachusetts Univ., Boston, MA
Modeling Abstraction and Simulation Techniques
Cassandras, Christos G.; Gong, Wei-Bo; Dec. 2002; 164 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): F30602-C-99-0056; F30602-C-99-0057; Proj-459S; Proj-459S
Report No.(s): AD-A411558; AFRL-IF-RS-TR-2002-314; No Copyright; Avail: CASI; A08, Hardcopy

This final report contains the joint work of both University of Massachusetts and Boston University who were each funded under separate contracts. The objective of this effort has been to develop and study three novel complementary directions that may be summarized as follows: 1. Extract information from the inherently slow simulation process of complex systems by exploiting new concurrent simulation techniques. 2. Exploit the hierarchical structure in multi-resolution models by decomposing them in ways which preserve statistical fidelity. 3. Explore the use of neural networks as complex simulation metamodels. The scope of the project has been to develop specific methodologies and algorithms based on the proposed new techniques that were developed and tested. In many cases, the benchmark problems studied are the same or extensions of the ones developed during our previous projects 'Enabling Technologies for Real-Time Simulation' and 'Real-Time Simulation Technologies for Complex Systems.'
DTIC
Simulation; Neural Nets; Models; Hierarchies

20030061385 Purdue Univ., West Lafayette, IN
Statistical Interpretation of Power Spectral Densities Measured by Picosecond Time-Resolved Laser-Induced Fluorescence in Turbulent Nonpremixed Flames
Laurendeau, Normand M.; King, Galen B.; Gore, Jay P.; Jan. 10, 2003; 92 pp.; In English
Contract(s)/Grant(s): F49620-00-1-0017; Proj-2308
Report No.(s): AD-A411482; AFRL-SR-AR-TR-03-0041; No Copyright; Avail: CASI; A05, Hardcopy

Picosecond time-resolved laser-induced fluorescence (PITLIF) has been applied to time-series measurements of OH, CH, and number density in turbulent nonpremixed flames with the intention of better understanding scalar fluctuation rates. Power spectral densities and autocorrelation functions were computed from the time series and then used to calculate integral time scales for many axial and radial locations in seven jet diffusion flames. The OH autocorrelation functions were found to collapse when normalized by their integral time scales. A stochastic model based on the laminar flamelet concept was developed to predict these integral time scales. Improvements over a prior version of this model and a more systematic application to H2/CH4/N2 flames permitted a reasonable prediction of the experimental trends. CH autocorrelation functions were also found to be self-similar except at locations close to the jet centerline or for Reynolds numbers approaching blowoff. Assumptions required for the time-series simulations were assessed via time-series measurements of total number density in the same flames, and the required input data were extracted by using time-averaged measurements from other research groups. Additional OH measurements in an H2/N2 jet flame provided the first direct comparison to integral time scales predicted from large-eddy simulations (LES). The predicted temporal scales were found to be a factor of two lower than the scalar

measurements, but the LES predictions reproduced the correct shape for the OH power spectral density.
DTIC
Laser Induced Fluorescence; Power Spectra; Combustion; Flames

20030061397 Fachhochschule, Jena, Germany
Joint Symbolic Dynamics Analysis of Heart Rate and Systolic Blood Pressure Interactions in Dilated Cardiomyopathy
Voss, A.; Baumert, M.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411179; No Copyright; Avail: CASI; A01, Hardcopy

The dilated cardiomyopathy (DCM) induces important changes in the autonomic control. Measures of heart rate (HR) variability and systolic blood pressure (SP) variability are sensitive to those changes. The interactions between HR and SP are rather complex and strongly non-linear. We introduced the joint symbolic dynamics (JSD) as a new short-term high resolution non-linear analysis method to investigate the complex interactions between HR and SP. Continuous non-invasive 30 minutes blood pressure recordings (Portapres) of 25 patients with DCM and 27 healthy controls (CON) were analyzed. HR and SP were extracted from the blood pressure time series on a beat-to-beat basis. Using the concept of JSD, HR and SP dynamics were transformed into a bivariate symbol vector. Subsequently, this symbol vector was transformed into a word series (words consisting of three successive symbols) and the probability of occurrence of each word type was calculated and compared between both groups. We found significant differences (partly $p<0.01$) in six word types between DCM and CON. JSD provides an efficient non-linear presentation of HR and SP interactions that offer rather simple physiological interpretations and seems to be particularly suitable for risk stratification in patients with dilated cardiomyopathy.
DTIC
Autonomic Nervous System; Heart Rate; Systolic Pressure; Nonlinear Equations; Cardiology

66
SYSTEMS ANALYSIS AND OPERATIONS RESEARCH

Includes mathematical modeling of systems; network analysis; mathematical programming; decision theory; and game theory.

20030061125 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Optimum Component Design in N-Stage Series Systems to Maximize the Reliability Under Budget Constraint
Gozebe, Huseyin; Mar. 2003; 119 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412859; AFIT/GOR/ENS/03-08; No Copyright; Avail: CASI; A06, Hardcopy

This research is intended to find a new heuristic for solving the reliability optimization of n-stage series system. The new heuristic will make the initial system design and use redundancy to improve system reliability level. The limited capacity of common optimization tools requires the new heuristic to be coded in VBA programming language. Moreover, the known reliability optimization heuristic, marginal analysis will be coded so that the difference between two heuristics can be seen and design engineers can use the best result in their applications.
DTIC
Optimization; Heuristic Methods

20030061167 Air Force Inst. of Tech Wright-Patterson AFB OH, Wright-Patterson AFB, OH, USA
Search Theory and U-Boats in the Bay of Biscay
Carl, Ronald G.; Mar. 2003; 70 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412844; AFIT/GOR/ENS/03-05; No Copyright; Avail: CASI; A04, Hardcopy

Threats to our nation's resources and forces are becoming increasingly lethal and mobile. Therefore, our ability to locate and interdict these threats is more important than ever. Search theory is one tool that is vital to countering the increasing threat. This research presents a multi-agent simulation, built around the Allied search for U-boats in the Bay of Biscay during World War II, which extends several classic search theory algorithms. Comparison of techniques is based on the effectiveness of finding high- valued, mobile assets. A JAVA-based multi-agent simulation model is designed, built and tested, and used to demonstrate the existence of differing emergent behaviors between search patterns currently used by the USA military.
DTIC
Detection; Target Recognition

20030061310 Indian Inst. of Tech., Kharagpur, India

Power Line Interference Removal from Electrocardiogram Using a Simplified Lattice Based Adaptive IIR Notch Filter

Dhillon, Santpal S.; Chakrabarti, Saswat; Oct. 25, 2001; 7 pp.; In English; Original contains color illustrations

Report No.(s): AD-A410842; No Copyright; Avail: CASI; A02, Hardcopy

In this paper we propose the use of a lattice based second order infinite impulse response (IIR) notch filter with a simplified adaptation algorithm for removal of power line frequency from ECG signals, The performance of this filter is better as compared to a second order infinite impulse response (IIR) notch filter for a real time ECG recording systems where the frequency of line varies over a narrow range about 50 Hz.

DTIC

Adaptive Control; Electrocardiography; Electromagnetic Interference; Iir Filters; Electric Power

67
THEORETICAL MATHEMATICS

Includes algebra, functional analysis, geometry, topology, set theory, group theory and number theory.

20030061114 Illinois Univ. at Urbana-Champaign, Urbana, IL, USA

Dynamic Skin Triangulation

Edelsbrunner, H.; Cheng, Ho-Lun; Dey, T. K.; Sullivan, J.; Jan. 2001; 45 pp.; In English

Contract(s)/Grant(s): DAAG55-98-1-0177

Report No.(s): AD-A410934; No Copyright; Avail: CASI; A03, Hardcopy

This paper describes an algorithm for maintaining an approximating triangulation of a deforming surface in R3. The surface is the envelope of an infinite family of spheres defined and controlled by a finite collection of weighted points. The triangulation adapts dynamically to changing shape, curvature, and topology of the surface.

DTIC

Surface Distortion; Triangulation

20030061156 Wroclaw Univ., Poland

Multiperspective Recognition Applied to the Computer-Aided Medical Diagnosis - A Comparative Study of Methods

Kurzynski, Marek W.; Puchala, Edward; 25 Oct. 2001; 5 pp.; In English

Report No.(s): AD-A412703; No Copyright; Avail: CASI; A01, Hardcopy

One of the most frequently used methods for computer-aided diagnosis is pattern recognition. The classical pattern recognition method assigns a given pattern to one and only one class from a given set of classes. In contrast, multiperspective classification is a process in which an object undergoes several classification tasks. Each task denotes recognition from a different point of view and with respect to different sets of classes. This work presents several different approaches to the algorithmization of multiperspective diagnosis and the implied decision algorithms. Several decision algorithms are presented for three different approaches to multiperspective classification (i.e., direct, decomposed independent, and decomposed dependent). These algorithms are the probabilistic (empirical Bayes) algorithm, the nearest-neighbor algorithm, fuzzy method, and artificial neural networks of the back propagation and counter propagation types. The proposed approaches and algorithms were applied to the computer-aided diagnosis of chronic renal failure and medical decisions in non-Hodgkins lymphoma. Results show that the best diagnostic outcome was achieved through use of the back propagation neural network. The probabilistic algorithm and the counter propagation neural network were less effective, and the fuzzy logic algorithm was the worst performer of all.

DTIC

Algorithms; Pattern Recognition; Medical Electronics; Diagnosis; Computer Techniques

20030061272 Saga Univ., Japan

Accurate Identification of Evoked Potentials by Waveform Decomposition Using Discrete Cosine Transform Modeling

Bai, O.; Nakamura, M.; Shibasaki, H.; Oct. 25, 2001; 5 pp.; In English

Report No.(s): AD-A412260; No Copyright; Avail: CASI; A01, Hardcopy

This paper introduces a method for decomposing the component responses of the evoked potentials. The decomposition was realized by zero-pole modeling of the evoked potentials in the discrete cosine transform (DCT) domain. It was found that the DCT coefficients of a component response in the evoked potentials could be modeled sufficiently by a second order transfer function in the DCT domain. The decomposition of the component responses was approached by using partial expansion of

the estimated model for the evoked potentials, and the effectiveness of the decomposition method was evaluated both qualitatively and quantitatively. Because of the overlap between the component responses, the proposed method enables an accurate identification of the component responses in the evoked potentials, which is useful for clinical and neurophysiological investigations. (2 figures, 9 refs.)
DTIC
Transfer Functions; Applications Of Mathematics

70
PHYSICS (GENERAL)

Includes general research topics related to mechanics, kinetics, magnetism, and electrodynamics. For specific areas of physics see *categories 71 through 77*. For related instrumentation see *35 Instrumentation and Photography*; for geophysics, astrophysics, or solar physics see *46 Geophysics, 90 Astrophysics*, or *92 Solar Physics*.

20030059494 Cairo Univ., Egypt
Optimal Design of RF Pulses With Arbitrary Profiles in Magnetic Resonance Imaging
Khalifa, Ayman M.; Youssef, Abou-Bakr M.; Kadah, Yasser M.; Oct. 25, 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411968; No Copyright; Avail: CASI; A01, Hardcopy

The proper design of RF pulses in magnetic resonance imaging has a direct impact on the quality of acquired images. Several techniques have been proposed to obtain the RF pulse envelope given the desired slice profile. Unfortunately, these techniques do not take into account the limitations of practical implementation such as limited amplitude resolution. Moreover, implementing constraints for special RF pulses on most techniques is not possible. In this work, we propose an approach for designing optimal RF under theoretically any constraints. The new technique poses the RF pulse design problem as a combinatorial optimization problem and uses efficient techniques from this area to solve this problem. In particular, an objective function is proposed as the norm of the difference between the desired profile and the one obtained from solving the Bloch equations for the current RF pulse design values. Two global optimization techniques were implemented using genetic algorithms and simulated annealing. The results show a significant improvement over conventional design techniques and suggest the practicality of using of the new technique for clinical use.
DTIC
Magnetic Resonance; Imaging Techniques; Electromagnetic Pulses

20030060412 California Univ., Lawrence Berkeley National Lab., Berkeley, CA, USA, Pukyong National Univ., Busan, Korea, Republic of
Efficient Imaging of Crosshole Electromagnetic Data
Kim, H. J.; Lee, K. H.; Wilt, M.; 2001; 10 pp.; In English
Report No.(s): DE2003-806121; No Copyright; Avail: Department of Energy Information Bridge

A computationally efficient inversion scheme has been developed using the extended Born or localized nonlinear (LN) approximation to analyze electromagnetic fields obtained in a crosshole environment. The medium is assumed to be cylindrically symmetric about the borehole, and to maintain the symmetry a vertical magnetic dipole is used as a source. The efficiency and robustness of an inversion scheme is very much dependent on the proper use of Lagrange multiplier, which is often provided manually to achieve a desired convergence. We have developed an automatic Lagrange multiplier selection scheme, which enhances the utility of the inversion scheme in handling field data. In this selection scheme, the integral equation (IE) method is quite attractive in speed because Green's functions, the most time consuming part in IE methods, are repeatedly re-usable throughout the selection procedure. The inversion scheme using the LN approximation has been tested to show its stability and efficiency using synthetic and field data.
NTIS
Boreholes; Electromagnetic Fields; Imaging Techniques; Lagrange Multipliers

20030060437 National Inst. of Standards and Technology, Gaithersburg, MD, USA
NIST Physics Laboratory 2002
2002; 56 pp.; In English
Report No.(s): PB2003-103398; No Copyright; Avail: CASI; A04, Hardcopy

The mission of the NIST Physics Laboratory is to support U.S. industry, government, and the scientific community by

providing measurement services and research for electronic, optical, and radiation technology. The Laboratory provides the foundation for metrology of optical and ionizing radiation, time and frequency, and fundamental quantum processes.
NTIS
Physics; Research Projects; Laboratories

20030060487 Texas Univ., Austin, TX, USA
A Thermal Hydraulic Model of Melt Lubrication in Railgun Armatures
Kothmann, R. E.; Stefani, F.; Mar. 2003; 28 pp.; In English
Contract(s)/Grant(s): DAAD17-01-D-0001
Report No.(s): AD-A411825; IAT.R-0214; No Copyright; Avail: CASI; A03, Hardcopy

This paper describes the first step toward a model of the liquid film at the rail/armature interface in solid armature railguns. It considers high-speed Couette flow with purely viscous heating and does not include MHD body forces or Joule heating. The focus is on coupled fluid dynamics and multi-phase heat transfer. The formulation is similar to the analysis of melt lubrication in rotating projectile bands, but our first principles model allows the possibility of solidification while the armature is passing, a feature that has been missing from previous analyses. The model is moderately successful at reproducing results of experiments which measured high-speed mechanical wear of 7075 aluminum sliding against ETP copper for face pressures ranging from 6 to 22 ksi. Discrepancies between calculated and experimental results are attributed to uncertainties in modeling the complex phase change behavior of aluminum alloy 7075 and uncertain conditions at the rail interface.
DTIC
Hydraulics; Armatures; Lubrication; Railgun Accelerators; Thermodynamic Properties

20030060550 Kansas State Univ., Manhattan, KS, USA
Monodisperse Ligand Stabilized Gold Nanoparticles: Understanding the Effects of Different Ligands
Prasad, B. L.; Stoeva, S.; Sorensen, Christopher; Klabunde, Kenneth J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 338; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

It is proposed that new types of crystalline materials could be grown in perfect shapes in microgravity. Especially promising are nanocrystal superlattices (NCSLs) based on gold, since gold is heavy and can readily be prepared in ligand stabilized nanocrystalline form. However in order to bring this idea to fruition better synthetic methods for preparing large amounts of cleanly monodisperse gold nanocrystals must be devised. This led to the discovery of a digestive ripening process. Indeed, we have found that heating a metal containing colloid at or near the solvent boiling point in the presence of a surface active ligand, is an extremely efficient procedure to prepare highly monodisperse colloids. This process has been called digestive ripening, and the usefulness of thiols as digestive ripening agents has already been established. In an effort to find alternative digestive ripening agents we have now used alkyl- amines, silanes, phosphines and halides. Amines and silanes were found to be similarly efficient for this purpose. The important steps involved in the digestive ripening have been identified as: 1 breaking the polydisperse colloid into a much smaller nanoparticles, 2 isolating these smaller particles from reaction side products, and 3 refluxing the isolated small nanoparticles in the presence of the ligand. The success of a ligand as a good digestive ripening agent is based on its capacity to break the bigger nanoparticles into smaller ones in the first step and its ability to adhere to the nanoparticle surface while the reaction side products are being removed in the second step. Though most of the ligands do a reasonably good job in the first step, some fail in the second step rendering them ineffective as digestive ripening agents. The similarities between the successful digestive ripening ligands will be discussed in detail. It was also found that irrespective of the head group, ligands with shorter alkyl chain lengths favor 3D ordering of the resulting monodisperse colloids while those with longer alkyl chain lengths lead to 2D lattices. The reasons for this are explained based on the decreasing van der Waals attraction between the gold particles as the distance between them is increased through the alkyl chain length of the capping ligand.
Author
Microgravity; Crystallinity; Crystal Growth; Gold; Nanostructures (Devices)

20030060660 NASA Marshall Space Flight Center, Huntsville, AL, USA
Radiation Pressure Measurements on Micron Size Individual Dust Grains
Abbas, M. M.; Craven, P.D.; Spann, J. F.; Tankosic, D.; Witherow, W. K.; LeClair, A.; West, E.; Sheldon, R.; Gallagher, D. L.; Adrian, M. L., et al.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

Measurements of electromagnetic radiation pressure have been made on individual silica (SiO2) particles levitated in an

electrodynamic balance. These measurements were made by inserting single charged particles of known diameter in the 0.2 micron to 6.82 micron range and irradiating them from above with laser radiation focused to beam-widths of approx. 175-400 micron, at ambient pressures approx. 10(exp -3) to 10(exp -4) torr. The downward displacement of the particle due to the radiation force is balanced by the electrostatic force indicated by the compensating dc potential applied to the balance electrodes, providing a direct measure of the radiation force on the levitated particle. Theoretical calculations of the radiation pressure with a least-squares fit to the measured data yield the radiation pressure efficiencies of the particles, and comparisons with Mie scattering theory calculations provide the imaginary part of the refractive index of silica and the corresponding extinction and scattering efficiencies.
Author
Silicon Dioxide; Radiation Pressure; Particles; Pressure Measurement; Laser Beams

20030061068 Air Force Research Lab., Edwards AFB, CA, USA
The Effects of Insulator Wall Material on Hall Thruster Discharges: A numerical Study
Fife, John M.; Locke, Summer; Jan. 3, 2001; 10 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410753; AFRL-PR-ED-TP-2001-002; No Copyright; Avail: CASI; A02, Hardcopy
An investigation was undertaken to determine how the choice of insulator wall material inside a Hall thruster discharge channel might affect thruster operation. In order to study this, an evolved hybrid particle-in-cell (PIC) numerical Hall thruster model, HPHall, was used. HPHall solves a set of quasi-one-dimensional fluid equations for electrons and tracks heavy particles using a PIC method.
DTIC
Hall Thrusters; Insulators; Hall Effect; Nozzle Walls

20030061166 Clemson Univ., SC, USA
Coupling of Electromagnetic Energy to a Wire Probe in/on a Missile
Butler, Chalmers M.; May 6, 2000; 5 pp.; In English
Contract(s)/Grant(s): DAAL03-92-G-0376
Report No.(s): AD-A412702; No Copyright; Avail: CASI; A01, Hardcopy
In this research program the electromagnetic field radiated and received by a thin-wire probe or antenna mounted on the nose cone of a missile is determined. The probe is connected to a component within the missile by a coaxial waveguide. The probe may be driven by a generator having a specified voltage and frequency or, in the reception mode, it may be loaded by a specified terminal impedance. The analyses developed allow for the probe to be mounted on the nose cone proper or it may reside within a cavity in the nose cone with coupling taking place between the missile interior and exterior through a small circular aperture in the cavity wall at the nose cone tip. For enhanced accuracy, alternate methods for addressing this problem were developed. Experimental models were fabricated and measurements were made to confirm the theoretical data. The agreement between theoretical and experimental data is excellent.
DTIC
Electromagnetic Fields; Probes

20030061257 Sierra Engineering Inc, Carson City, NV, USA, Alabama University, Birmingham, AL, USA
Numerical Cold Flow and Combustion Characterization of Swirl Coaxial Injectors
Muss, Jeffrey A.; Johnson, Curtis W.; Cheng, Gary C.; Dec. 27, 2002; 16 pp.; In English
Contract(s)/Grant(s): Proj-3058
Report No.(s): AD-A410890; AFRL-PR-ED-TP-2002-323; No Copyright; Avail: CASI; A03, Hardcopy
The Air Force and its partners are developing and validating an injector design methodology that utilizes both high-pressure cold-flow testing and uni-element hot-fire testing, to create a high performing, long life swirl coaxial injector. Several gas-centered swirl coax injector configurations have been tested under cold- flow and hot-fire test conditions in a single element research engine. The methodology uses computational fluid dynamics (CFD) analyses to provide insight into the flowfield and guide the evolution of injector designs. Both cold-flow and hot-fire analyses were completed, with cold flow results compared with test data. The companion paper will discuss the experimental results.
DTIC
Combustion; Computational Fluid Dynamics; Injectors; Transmission; Cold Flow Tests

20030061303 Air Force Research Lab., Edwards AFB, CA, USA
Stress Intensity Factors and Crack Paths for Cracks in Photoelastic Motor Grain Models
Smith, C. W.; Constantinescu, D. M.; Liu, C. T.; May 22, 2002; 10 pp.; In English
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410794; AFRL-PR-ED-TP-2002-129; No Copyright; Avail: CASI; A02, Hardcopy

Computational analysis and two dimensional tensile tests on single motor grain fins suggest that cracks in fin tips are most likely to originate at the coalescence of the fin end tip radius with a small radius emanating from the side of the fin. Prior studies have indicated that under internal pressure, cracks on the fin axis are subject to similar stress peaks and may grow more readily than the former types due to the absence of shear modes. The present study focuses upon two types of cracks emanating from the former location called 'off-axis' cracks and attempts to differentiate from the two types by their paths and SIP values, determined by the frozen stress photoelastic - method.
DTIC
Stress Intensity Factors; Photoelasticity; Crack Propagation; Fins; Shear Properties; Cracks

20030061432 Kansas Univ., Lawrence, KS
Fabrication of High-T(c) Superconducting Infrared Detectors Using Ion-Beam-Assisted Thermal Co-Evaporation
Wu,; May 31, 2002; 12 pp.; In English
Contract(s)/Grant(s): F49620-99-1-0279; Proj-3484
Report No.(s): AD-A411474; AFRL-SR-AR-TR-03-0037; No Copyright; Avail: CASI; A03, Hardcopy

The IBATCE system will be used to initiate an extensive research on oxide materials, such as fabrication of HTS bolometer infrared detectors, through collaboration with DoD laboratories and other institutions. The driving force for this research is the DoD's need for high-sensitivity infrared detectors in long-/very-long wavelength ranges. The focus of the proposed research is to understand the growth mechanism of the HTS multilayer-structured bolometer infrared detectors in IBATCE process and to obtain high device performance by optimizing the thin-film quality and device designs. The long-term goal of this research is to build a competitive project in Kansas in the emerging field of oxide materials and to bring in significant amount of federal research funds. The requested DEPSCoR fund is crucial to the success of the proposed research and such a success certainly benefits the State of Kansas economy and meets the goal of DEPSCoR program.
DTIC
High Temperature Superconductors; Infrared Detectors; Bolometers; Ion Beams

71
ACOUSTICS

Includes sound generation, transmission, and attenuation. For noise pollution see *45 Environment Pollution*. For aircraft noise see also *02 Aerodynamics* and *07 Aircraft Propulsion and Power*.

20030059507 Technical Univ. of Istanbul, Turkey
Segmentation of Ultrasound Images by Using An Incremental Self-Organized Map
Kurnaz, M. N.; Dokur, Z.; Olmez, T.; Oct. 25, 2001; 4 pp.; In English
Report No.(s): AD-A412331; No Copyright; Avail: CASI; A01, Hardcopy

This paper presents a new segmentation method for ultrasound images. A new incremental self-organized map is proposed for the segmentation of the ultrasound images. Elements of the feature vectors are formed by the fast Fourier transform (FFT) of image intensities in 4.4 square blocks. In this study, two neural networks for segmentation are comparatively examined: Kohonen map, and incremental self-organized map (ISOM). It is observed that ISOM gives the best classification performance with less number of nodes after a short training time.
DTIC
Ultrasonics; Image Classification; Imaging Techniques

20030059510 Wales Univ., Bangor, UK
Beam Distortion in Doppler Ultrasound Flow Test Rigs: Measurement Using a String Phantom
Steel, R.; Fish, P. J.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A412354; No Copyright; Avail: CASI; A01, Hardcopy

The tube in flow rigs used for testing Doppler ultrasound instruments can attenuate and distort the beam and sample volume by refraction, reflection, absorption and mode conversion. The attenuation and degree of distortion has been measured

by using a moving string test object and candidate tubes have been compared. Tubes of rubber, TFE-Teflon, Perspex, heatshrink and C-Flex have been tested leading to the choice of O.8mm wall C-Flex.
DTIC
Ultrasonics; Wave Attenuation; Flow Distortion; Flow Measurement; Pipes (Tubes); Beams (Radiation)

20030059517 Karolinska Inst., Stockholm, Sweden
Angular Error in Ultrasound Doppler Tissue Velocities and Its Influence on the Derived Variable Peak Systolic Strain
Storaa, Camilla; Brodin, Lars-Ake; Lind, Britta; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A412453; No Copyright; Avail: CASI; A01, Hardcopy

When recording velocities using ultrasound Doppler, the obtained velocities are always a projection of the true velocities onto the direction from the recording point towards the transducer. In this study we have marked up lines in sequences of ultrasound images of the heart showing the direction of the original velocity. Doing this, it is possible to calculate the original velocity in the marked direction. Both the recorded and corrected velocities have been used for calculating strain, in order to compare the two. Apical ultrasound images have been recorded on a sample of 18 normal individuals. The corrected velocities are on the average less than 5\% higher than the recorded ones, and the effect on the derived variable strain is even less, so we suggest that the correction can be omitted when recording tissue velocities through an apical window.
DTIC
Stress-Strain Relationships; Tissues (Biology); Recording Instruments

20030059529 Swedish Defence Research Establishment, Stockholm, Sweden
Transparent Boundary Conditions for Parabolic Equations in Underwater Acoustics
Karlsson, P.; Mar. 2002; In English
Report No.(s): PB2003-103171; FOI-R-0459-SE; No Copyright; Avail: National Technical Information Service (NTIS)

In this thesis the creation of discrete transparent boundary conditions (DTBC's) for parabolic wave equations (PE's) in underwater acoustics is treated. The DTBC's are obtained by using analytical solutions to PE's for a semi-infinite and homogeneous bottom. These new boundary conditions have been compared with the method of damping layers, which until recently was the common way to truncate an infinite bottom. Three testing examples were used for the evaluation: the Lloyd mirror, the Bucker wave-guide and the Jensen-Kuperman wedge. The authors used three different damping profiles in the evaluation, two linear and one non-linear. The DTBC's showed to be much more time efficient and correct than the damping layer method. A first display of the functionality of the DTBC can be seen on the front page, which shows the evolution of a beam hitting wedge shaped prism in a homogeneous water half-space. As seen from the figure the part of the beam that encounters the surface is reflected back while the bottom boundary is transparent.
NTIS
Underwater Acoustics; Boundary Conditions; Parabolic Differential Equations; Wave Equations

20030060673 Woods Hole Oceanographic Inst., MA, USA
ONR Acoustic Observatory Science Plan Workshop
Lynch, James F.; Jun. 2002; 60 pp.; In English
Contract(s)/Grant(s): N00014-02-1-0345
Report No.(s): AD-A412675; No Copyright; Avail: CASI; A04, Hardcopy

Under ONR grant, work was performed in support of the Acoustic Observatory science plan. Specifically, the P.I. (Dr. James Lynch, WHOI) worked closely with Drs. Norman Owsley and Douglas Abraham in planning, hosting, and reporting on a two-day workshop held at Newport, R.I. during June of 2002. This workshop formulated an overall science plan for the Acoustic Observatory, which will be used in guiding its funding and operation over the next five years. The formal report of this workshop is contained in a collection entitled 'White papers submitted for consideration at the ONR Acoustic Observatory Science Plan Workshop, Newport, R.I. June 25-26, 2002'
DTIC
Oceanography; Underwater Acoustics; Sonar; Signal Transmission

20030060674 Paris VI Univ., France
Theoretical Study of Harmonic Generation Sound Beams in Case of Uniform, Exponential and Cosinusoidal Apertures
Kourtiche, D.; Ait Ali, L.; Chitnalah, A.; Nadi, M.; Oct. 25, 2001; 5 pp.; In English
Report No.(s): AD-A412416; No Copyright; Avail: CASI; A01, Hardcopy

The nonlinear propagation of ultrasound in medical imaging has recently been exploited to improve image resolution and remove near field artifacts generated by overlying tissue structures. The images are formed using the second harmonic energy generated by nonlinear propagation. Second harmonic beams have narrower beam width and lower side lobes than the fundamental. The second harmonic draws energy from the fundamental continuously along the propagation path. These characteristics contribute to improve the quality of medical ultrasound images. In this paper, our objective is to show that the choice source aperture has significant consequences on the quality of the field transmitted in term of directivity. We also studied the field generated by three apertures sources, in a nonlinear medium. Theoretical approach, based on Khokhlov-Zabolotskaya-Kuznetsov (KZK) parabolic approximation is used in order to consider the diffraction effects related to the use of a focusing real source. The fundamental ultrasonic fields and the second harmonic are compared at three distances from the source. Width and side lobes were used when recording three distributions of the beam form.
DTIC
Ultrasonics; Nonlinearity; Acoustic Propagation

20030061108 Engineering Research and Consulting Inc (ERC Inc) Edwards AFB CA, Edwards AFB, CA, USA
Interaction of Acoustic Waves with a Cryogenic Nitrogen Jet at Sub- and Supercritical Pressures
Chehroudi, B.; Talley, D.; Dec. 2001; 17 pp.; In English
Contract(s)/Grant(s): Proj-2308
Report No.(s): AD-A410887; ERC-E01-047; AFRL-PR-ED-TP-2001-245; No Copyright; Avail: CASI; A03, Hardcopy

To better understand the nature of the interaction between acoustic waves and liquid fuel jets in rocket engines, cryogenic liquid nitrogen is injected into a room temperature high-pressure chamber having optical access on its sides. A piezo-siren capable of generating sound waves with an SPL of up to 180 dB is used under three chamber pressures of 1.46, 2. 48, and 4.86 MPa. The reduced pressures for these pressures are 0.43 (subcritical), 0.73 (near-critical), and 1.43 (supercritical), respectively. The assembly consisting of the acoustic driver and the high- pressure chamber form a cavity that resonates at several frequencies, the strongest being at 2700 and 4800 Hz. Three different flow rates are considered and the nature of the aforementioned interaction has been documented via a high-speed imaging system using a CCD camera. It is found that the impact of the acoustic waves on the jet structure is strongest from low to near-critical chamber pressures and at low injectant flow rates. No significant effects of the acoustic waves are detected at the supercritical chamber pressure examined. It suggests that engine operation either near the critical point or in transition passing through the critical point could be troublesome and may lead to or feed combustion instabilities in liquid rocket engines. Further work is needed to directly relate these effects to the observed instabilities.
DTIC
Sound Waves; Jets; Liquid Rocket Propellants; Liquid Nitrogen

20030061145 North Carolina State Univ., Raleigh, NC, USA
Tailoring of Acoustic and Optical Phonon Modes in Mesoscopic and Nanoscale Semiconductor Structures
Stroscio, M. A.; Jan. 1998; 7 pp.; In English
Contract(s)/Grant(s): DAAG55-98-D-0003
Report No.(s): AD-A410816; ARO-39108.8-EG-SR; No Copyright; Avail: CASI; A02, Hardcopy

We have considered scattering rates and confined phonon modes in nitride-based confined nitride-based III-V heterostructures as well as the phonon modes in carbon nanotubes and buckyballs. We have examined phonons in a variety of nanostructures and related applications in optoelectronics, thin films, thermal systems, nanotubes, and buckyballs. An especially significant finding of this research is the finding that quantized elastic continuum modes describe the acoustic phonon modes in nanostructures with a high degree of accuracy.
DTIC
Optical Properties; Acoustics; Phonons; Nanostructures (Devices); Semiconductor Devices

20030061169 Michigan Univ., Ann Arbor, MI
Characterization of Breast Masses Using a New Method of Ultrasound Contrast Agent Imaging in 3D Mapping of Vascular Anomalies
LeCarpentier, Gerald; Oct. 2002; 15 pp.; In English
Contract(s)/Grant(s): DAMD17-01-1-0327
Report No.(s): AD-A412851; No Copyright; Avail: CASI; A03, Hardcopy

Doppler ultrasound and other imaging modalities have been used to assess characteristics of vasculature associated with

malignant breast masses. Specific to our institution, promising results have been achieved in discriminating benign from malignant masses using Doppler vascularity measures in conjunction with ultrasound grayscale features. The purpose of this work is to develop an innovative dual-transducer method to control the destruction and imaging of ultrasound contrast during 3D ultrasound scanning of suspicious breast masses. This method, which involves sequential scanning and co-registration of image volumes acquired during contrast refill, should provide mapping of vascularity around these masses and highlight the associated anatomic variation in mean transit time. In the coming year, this new imaging scheme will be evaluated in a small patient population to begin to establish the refill characteristics for a variety of suspicious breast masses, and appropriate mathematical models will be developed to characterize contrast agent refilling,following destruction specific to the dual-transducer system. Experimental assessment of contrast agent life-span, destruction characteristics, and refill imaging has been undertaken in flow phantoms. A software system will be developed to visualize quantification of regional perfusion in and around the region of interest. Year one results are presented here.
DTIC
Ultrasonics; Mammary Glands; Cancer

20030061351 Department of the Navy, Washington, DC
Target Track Crossing Prediction/Detection
Struzinski, William A., Inventor; Aug. 8, 2002; 12 pp.; In English
Patent Info.: Filed 8 Aug. 2002; US-Patent-Appl-SN-10214551
Report No.(s): AD-D020053; No Copyright; Avail: Other Sources

A method and system are provided for predicting and detecting the crossing of two target tracks in a bearing versus time coordinate frame. The method/ system uses a series of periodic bearing measurements of the two target tracks to determine a bearing rate and a projected intercept with a bearing axis of the bearing versus time coordinate frame. A crossing time (t sub c) for the two target tracks is determined using the tracks bearing rates and projected intercepts. A prediction that the two target tracks will cross results if a first inequality is satisfied while a detection that the two target tracks have crossed results if a second inequality is satisfied.
DTIC
Target Acquisition; Tracking Radar; Sonar; Tracking (Position); Crossings; Prediction Analysis Techniques

20030061378 Georgetown Univ., Washington, DC, USA
High-Resolution Speckle-Free Ultrasound Imaging System: A Potential Solution for Detecting Missed Breast Cancer
Freedman, Matthew T.; Oct. 2002; 15 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): DAMD17-00-1-0599
Report No.(s): AD-A411249; No Copyright; Avail: CASI; A03, Hardcopy

The Imperium Inc transmission ultrasound system is a highly promising novel method for imaging the breast. In this pilot project, we are to work with Imperium to advise and help them modify their existing system for non-destructive testing into one suitable for breast imaging, perform a physics evaluation and perform a small clinical pilot feasibility trial. The initiation of this project has been delayed by non-approval of the human use portion of the project. As of October, 2002, we have just received US Army Human Use approval for study of tissue samples. This has been resubmitted to the Georgetown IRB for approval of modifications requested by the US Army's reviewer. During this past year we provided technical advice to Imperium, but have not been able to conduct the detailed tests as planned. I am hopeful that the Georgetown IRB will agree to the changes requested by the US Army Human Subjects Reviewers so we can start. During the wait for Human Use approval, we have been meeting with Imperium and they have improved the system that we will be testing. We will describe some of these improvements in this annual report.
DTIC
Ultrasonics; Mammary Glands; Cancer

72
ATOMIC AND MOLECULAR PHYSICS

Includes atomic and molecular structure, electron properties, and atomic and molecular spectra. For elementary particle physics see *73 Nuclear Physics*.

20030061066 Air Force Research Lab., Edwards AFB, CA, USA
Spectral Inhomogeneity as a Discrete, Countable Entity - The Role of Residual oH2 Molecules on the RoVibrational Spectra of Dopants in pH2 Solids
Fjardo, Mario; Tam, Simon; Jun. 5, 2001; 23 pp.; In English; International Symposium on Molecular Spectroscopy (56th), 11-15 Jun. 2001, Columbus, OH, USA
Contract(s)/Grant(s): Proj-2302
Report No.(s): AD-A410744; AFRL-PR-ED-VG-2001-130; No Copyright; Avail: CASI; A03, Hardcopy
Absorption Spectra; Vibrational Spectra; Infrared Spectroscopy; Inhomogeneity

20030061084 Army Engineer Research and Development Center, Vicksburg, MS, USA
UV-VIS Spectroscopy of 2,4, 6-Trinitrotoluene-Hydroxide Reaction
Felt, Deborah R.; Larson, Steven L.; Valente, Edward J.; Aug. 2002; 75 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412729; ERDC/EL-TR-02-22; No Copyright; Avail: CASI; A04, Hardcopy

Contamination of groundwater, surface water, and soil by explosives has occurred at military sites throughout the world as a result of manufacture of explosive compounds, assembly of munitions, and deployment of explosives containing devices. As a result of the adverse effects of explosives on humans and environmental receptors, a low-cost means of decontaminating explosives and energetics contaminated areas is needed. Base-induced transformation of explosives shows promise as a rapid, low-cost technology for detoxifying explosives in soil and water. To understand the reaction mechanism, a reaction mixture of 2:1:1 (water: 100 ppm 2,4, 6-trinitrotoluene (TNT): 1N KOH) was analyzed by ultraviolet-visible (UV/VIS) spectrometry from 190 to 1,100 nm. Time course measurements were conducted at 25, 20,15, and 12 C. A factor analysis program was used to analyze the spectral data. Principal component analysis indicated that six principal components explained the spectra to within experimental error, with four factors explaining the majority of the variance. Test spectral vectors for four components were developed, including TNT, two intermediates, and the final product, and tested against the abstract vectors. Two possible reaction mechanisms were suggested and tested to explain the spectral data.
DTIC
Decontamination; Explosives; Ultraviolet Spectroscopy; Trinitrotoluene

73
NUCLEAR PHYSICS

Includes nuclear particles; and reactor theory. For space radiation see *93 Space Radiation*. For atomic and molecular physics see *72 Atomic and Molecular Physics*. For elementary particle physics see *77 Physics of Elementary Particles and Fields*. For nuclear astrophysics see *90 Astrophysics*.

20030061131 Air Force Inst. of Tech., Wright-Patterson AFB, OH, USA
Investigation of a Passive, Temporal, Neutron Monitoring System that Functions within the Confines of Start I
Vaughn, Stephanie; Mar. 2003; 92 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412872; AFIT/GNE/ENP/03-10; No Copyright; Avail: CASI; A05, Hardcopy

This study is an investigation of the theoretical and experimental possibilities of using activation foils to detect and monitor special nuclear material for treaty monitoring purposes. None of the experiments demonstrated sufficient sensitivity to detect the target flux of 0.5 neutrons/cu cm--sec. The target flux could be detectable, if the limit of detection had been reduced by a factor of 4 to 6. However, many issues identified could enhance the sensitivity including: increasing foil size, increasing detector efficiency, and optimizing foil selection. The theoretical portion focused on gold, silver, indium, europium, and gadolinium foils and determined the minimum flux detectable, minimum time needed to detect a specific flux, and what gaps in coverage exist when a detection package consists of all combined foils. All calculations are based on actual gamma and beta detector responses and statistics in a high and low background. The second section consists of experiments with gold, indium, and silver foils. Detectors in a low background counted emitted gammas or betas to establish three-sigma limits of detection, which is the lowest neutron flux detectable with a 99 percent statistical reliability. The dominant factor in determining the limit of detection is the error associated with the total activity. The determined value for limit of detection

was used to calculate the minimum foil surface area required to detect the target flux.
DTIC
Radioactive Materials; Flux (Rate); Foils (Materials)

74
OPTICS

Includes light phenomena and the theory of optical devices; for specific optical devices see also *35 Instrumentation and Photography*. For lasers see *36 Lasers and Masers*.

20030059486 Lawrence Livermore National Lab., Livermore, CA
Highly Efficient Tabletop Optical Parametric Chirped Pulse Amplifier at 1 Micron
Jovanovic, I.; Ebbers, C. A.; Comaskey, B. J.; Bonner, R. A.; Morse, E. C.; Dec. 04, 2001; 16 pp.; In English
Report No.(s): DE2003-803431; UCRL-JC-145349; No Copyright; Avail: Department of Energy Information Bridge

Optical parametric chirped pulse amplification (OPCPA) is a scalable technology, for ultrashort pulse amplification. Its major advantages include design simplicity, broad bandwidth, tunability, low B-integral, high contrast, and high beam quality. OPCPA is suitable both for scaling to high peak power as well as high average power. We describe the amplification of stretched 100 fs oscillator pulses in a three-stage OPCPA system pumped by a commercial, single-longitudinal-mode, Q-switched Nd:YAG laser. The stretched pulses were centered around 1054 nm with a FWHM bandwidth of 16.5 nm and had an energy of 0.5 nJ. Using our OPCPA system, we obtained an amplified pulse energy of up to 31 mJ at a 10 Hz repetition rate. The overall conversion efficiency from pump to signal is 6\%, which is the highest efficiency obtained With a commercial tabletop pump laser to date. The overall conversion efficiency is limited due to the finite temporal overlap of the seed (3 ns) with respect to the duration of the pump (8.5 ns). Within the temporal window of the seed pulse the pump to signal conversion efficiency exceeds 20\%. Recompression of the amplified signal was demonstrated to 310 fs, limited by the aberrations initially present in the low energy seed imparted by the pulse stretcher. The maximum gain in our OPCPA system is 6x10 to the seventh power, obtained through single passing of 40 mm of beta-barium borate. We present data on the beam quality obtained from our system (M(sup 2)=1.1). This relatively simple system replaces a significantly more complex Ti:sapphire regenerative amplifier based CPA system used in the front end of a high energy short pulse laser. Future improvement will include obtaining shorter amplified pulses and higher average power.
NTIS
Pulsed Radiation; Electromagnetic Pulses; Amplifiers

20030060438 National Inst. of Standards and Technology, Gaithersburg, MD, USA
Report of the Results of SIM.QM-P6: UV/Visible Spectrophotometry Wavelength Standard Interlaboratory Comparison
Travis, J. C.; Smith, M. V.; Duewer, D. L.; Jan. 2003; 44 pp.; In English
Report No.(s): PB2003-104207; NISTIR-6961; No Copyright; Avail: CASI; A03, Hardcopy

A study was designed to compare wavelength axis measurements in ultraviolet and visible (uv/vis) spectrometry at several laboratories of the InterAmerican Metrology System (Sistema InterAmericano de Metrologia, or SIM) using holmium oxide solution Certified Reference Materials (CRMs). The goals of the study were to demonstrate comparability of wavelength measurements among the participants, to demonstrate the comparability between National Institute of Standards and Technology (NIST) and Centro Nacional de Metrologia (CENAM) versions of holmium oxide in perchloric acid solution CRMs, to acquire holmium oxide solution spectral data from a variety of spectrometers for use in a NIST study of wavelength assignment algorithms, and to provide a basis for a possible reassessment of the NIST-certified wavelength values. The goals were generally met, with widespread agreement of the measurements, evidence that sample origin is irrelevant, and support for re-assignment of the NIST-certified wavelength values for absorption band positions in SRM 2034.
NTIS
Standards; Spectrophotometry; Wavelengths

20030060488 Defence Research and Development Canada, Ottawa, Ontario, Canada
CAMEVAL-2002 Land Forces Signature Reduction Trial: Ground Truthing, Calibration and Multi-Sensor Data Acquisition for DRDC Experiments
Secker, Jeff; English, Ryan A.; Yeremy, Maureen; Levesque, Josee; Nov. 2002; 81 pp.; In English; Original contains color illustrations
Report No.(s): AD-A411983; DRDC-TM-2002-121; No Copyright; Avail: CASI; A05, Hardcopy

The CAMEVAL-2002 Land Forces Signature Reduction (LFSR) trial was conducted at the Canadian Forces Base (CFB) Petawawa in June 2002. For the LFSR trial, 27 military vehicles (primarily Leopard C2 tanks and Coyote reconnaissance vehicles) were deployed under forest canopy, along tree lines and in open field. A subset of the Leopards and Coyotes was deployed with a trial camouflage screen, another subset was covered with the current in-service camouflage, and a final subset was left uncovered. During the LFSR trial, Defence Research and Development Canada (DRDC) Ottawa and DRDC Valcartier acquired airborne and spaceborne Synthetic Aperture Radar (SAR) imagery and airborne Hyperspectral Imagery (HSI) data over the trial sites, and conducted extensive calibration and ground truthing activities in support of these acquisitions. This report documents the SAR and HSI data acquisition, ground truthing and calibration activities completed during the trial, thereby providing the foundation for any future analyses that use these multi-sensor data. This report also describes the five DRDC Ottawa and DRDC Valcartier analyses that were planned at the time of the trial.
DTIC
Ground Truth; Data Acquisition; Calibrating; Combat; Multisensor Fusion

20030060658 Osaka Univ., Osaka, Japan
Integration and Immersive Presentation of Various Head Information
Oshiro, O.; Imura, M.; Suga, M.; Minato, K. M.; Chihara, K.; 25 Oct. 2001; 5 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412591; No Copyright; Avail: CASI; A01, Hardcopy

This paper describes the measurement of various head images and the presentation of integrated images on an immersive projection system (IPS). We handled optical and magnetic method to obtain the information about face, head, brain and blood vessel. The system enables to observe the inside of a head interactively using a joystick, which gives the impression to travel in a human head freely. It is thought that the integrated images are available not only for diagnosis but also treatment of a brain in the future robot surgical operation with a manipulator or a micro-machining device.
DTIC
Head (Anatomy); Images; Magnetic Resonance; Imaging Techniques

75
PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion. For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

20030060414 Brookhaven National Lab., Upton, NY, USA
HYSPEC: A Crystal Time-of-Flight Hydrid Spectrometer for the Spallation Neutron Source
Shapiro, S. M.; Zaliznyak, I. A.; Jan. 27, 2003; In English
Report No.(s): DE2003-807277; BNL-52677; No Copyright; Avail: National Technical Information Service (NTIS)

The study of phase transitions and novel ordered phases in complex systems remains at the forefront of condensed-matter research. In studies of superconductivity, magnetism, ferroelectricity, colossal magnetoresistance, charge order, etc., one is interested in determining how each type of order occurs, including how and why it arises from the disordered state. The energy scale for excitations that have an impact on ordering is typically on the order of a few to tens of meV; this is the same energy scale for excitations that impact transport properties. The intensities and energy resolutions obtainable with thermal neutrons are ideal for such inelastic studies. At the same time, one needs to be able to detect and monitor the relevant order parameter through elastic diffraction measurements, which frequently involves measurements of superlattice peaks that may be extremely weak. Often one wishes to study correlations that have not achieved long-range order, in which case one must measure diffuse scattering and be able to discriminate elastic from inelastic contributions.
NTIS
Neutron Sources; Spallation; Time Of Flight Spectrometers

20030060648 National Space Science and Technology Center, Huntsville, AL, USA, NASA Marshall Space Flight Center, Huntsville, AL, USA
Magnetospheric Convection Electric Field Dynamics and Stormtime Particle Energization: Case Study of the Magnetic Storm of May 4,1998
Khazanov, George V.; Liemohn, Michael W.; Newman, Tim S.; Fok, Mei-Ching; Ridley, Aaron; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

It is shown that narrow channels of high electric field are an effective mechanism for injecting plasma into the inner magnetosphere. Analytical expressions for the electric field cannot produce these channels of intense plasma flow, and thus result in less entry and energization of the plasma sheet into near-Earth space. For the ions, omission of these channels leads to an underprediction of the strength of the stormtime ring current and therefore an underestimation of the geoeffectiveness of the storm event. For the electrons, omission of these channels leads to the inability to create a seed population of 10-100 keV electrons deep in the inner magnetosphere. These electrons can eventually be accelerated into MeV radiation belt particles.
Author
Magnetic Storms; Plasmas (Physics); Electric Fields; Particle Energy; Magnetohydrodynamic Flow; Earth Magnetosphere

20030061079 Air Force Research Lab., Edwards AFB, CA, USA
The Development of a Flexible, Usable Plasma Interaction Modeling System
Fife, J. M.; Gibbons, M. R.; VanGilder, D. B.; Kirtley, D. E.; Jun. 13, 2002; 10 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410797; AFRL-PR-ED-TP-2002-145; No Copyright; Avail: CASI; A02, Hardcopy

A 3-D computational plasma interaction modeling system is being developed to predict the interaction of electric propulsion plumes with surfaces. The system, named COLISEUM, is designed to be flexible, usable, and expandable, allowing users to define surfaces with their choice of off-the-shelf 3-D solid modeling packages. These surfaces are then loaded into COLISEUM which performs plasma operations based on user commands. Functional modules are interchangeable, and can range from simple (prescribed plume field) to complex (PIC-DSMC). Surface interaction parameters such as ion flux, ion energy, sputtering, and re-deposition are computed. Development to date has progressed to include the two simplest functional modules: prescribed plume, which imports and superimposes a plume distribution, and ray, which performs ray tracing of flux from point sources. This paper presents a new COLISEUM algorithm for calculating equilibrium resputtering and re-deposition of materials. This algorithm enables calculation of net deposition and sputtering of surfaces inside HET test facilities as well as in the space environment. Two cases are presented - one for a laboratory experiment in which sputtering and redeposition were measured, and another in which sputtering and redeposition on a generalized geosynchronous spacecraft is predicted.
DTIC
Plasmas (Physics); Plumes; Electric Propulsion; Computer Programs; Hall Thrusters

20030061105 NASA Marshall Space Flight Center, Huntsville, AL, USA
Toroidal wave frequency at L=6-10: AMPTE/CCE Observations and Comparison with Theoretical Model
Takahashi, Kazue; Denton, Richard E.; Gallaher, Dennis; [2003]; 2 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

Magnetospheric standing Alfven waves are guided along the ambient magnetic field and their frequency depends on the mass density of the plasma distributed along the field lines. These properties allow us to use Alfen waves to map time-dependent phenomena between space and ground and to estimate the mass density. In this paper we present a statistical study of the spatial variation of the fundamental frequency f(sub T1) of toroidal-mode standing Alfen waves in the L range from 6 to 10, where L indicates the maximum geocentric distance on the field line. The data used for this analysis are energetic particle flux anisotropy (proxy of transverse electric field) and magnetic field measurements from the Active Magnetospheric Particle Tracer Explorers Charge Composition Explorer (CCE) spacecraft. Using CCE data covering 4 years we obtained approximately 5000 20-min intervals containing a clear signature of toroidal waves. The median f(sub T1), is 6-10 mHz at L=7 and decreases to 4-8 mHz at L = . The frequency tends to be lower at noon than at midnight. The observed frequencies are compared with numerically derived frequencies using an empirical mass density model and a magnetic field model. We found a good agreement for 12-24 MLT but a large discrepancy near MLT= 3. This may indicate that the flux tubes at this local time are more heavily loaded than specified in the Gallagher et al. model.
Author
Magnetohydrodynamic Waves; Mathematical Models; Magnetic Fields; Density Measurement; Magnetic Flux; Time Dependence; Spatial Dependencies; Plasmas (Physics)

20030061155 Air Force Research Lab., Edwards AFB, CA, USA
3-D Computation of Surface Sputtering and Redeposition Due to Hall Thruster Plumes
Fife, J. M.; Gibbons, M. R.; Hargus, W. A.; VanGilder, D. B.; Kirtley, D. E.; Dec. 23, 2002; 11 pp.; In English
Contract(s)/Grant(s): Proj-4847
Report No.(s): AD-A410863; AFRL-PR-ED-TP-2002-319; No Copyright; Avail: CASI; A03, Hardcopy

A 3-D computational plasma interaction modeling system is being developed to predict the interaction of electric propulsion plumes with surfaces. The system, named COLISEUM, Is designed to be flexible, usable, and expandable, allowing users to define surfaces with their choice of off-the-shelf 3-D solid modeling packages. These surfaces are then loaded into COLISEUM, which calculates plasma expansion from electric thrusters using a variety of functional modules. Functional modules are interchangeable, and can range from simple (collisionless ray tracing) to complex (PIC-DSMC). Surface interaction parameters such as ion flux, ion energy, sputtering, and re-deposition are computed. Development to date has progressed to include the two simplest functional modules: PRESCRIBED_PLUME, which imports and superimposes a plume distribution, and RAY, which performs ray tracing of flux from point sources. This paper presents a new COLISEUM algorithm for calculating equilibrium re-sputtering and re-deposition of materials. This algorithm enables calculation of net deposition and sputtering of surfaces inside HET test facilities as well as in the space environment Two cases are presented - one for a laboratory experiment in which sputtering and redeposition were measured, and another in which sputtering and redeposition on a generalized geosynchronous spacecraft is predicted.
DTIC
Plasmas (Physics); Plumes; Sputtering; Hall Thrusters; Three Dimensional Models; Computer Programs

20030061355 Air Force Research Lab., Edwards AFB, CA, USA
Resonant Operation of a Micro-Newton Thrust Stand
Lake, James P.; Cavallaro, Greg; Spanjers, Greg; Adkison, Paul B.; Dulligan, Michael J.; Jan. 9, 2003; 15 pp.; In English
Contract(s)/Grant(s): Proj-1011
Report No.(s): AD-A411147; AFRL-PR-ED-TP-2002-308; No Copyright; Avail: CASI; A03, Hardcopy

A computer automated technique suitable for evaluating micro pulsed plasma thruster (micro PPT) performance has been constructed and validated in the micro-Newton (micro N) force range. A swinging gate pendulum architecture oscillates with an 8 second period. Force is applied resonantly with oscillation each half period. The calibration method utilizes an electromagnet to pick up and drop masses to apply a known force in the same resonant fashion as thruster operation. The resulting equilibrium amplitudes are linearly proportional to the applied force with an intercept near zero. Thrust measurements are insensitive to short term random vibrational noise because of the resonant operation and are insensitive to long term drift because the amplitude measurements are relative, rather than absolute. The system is capable of resolving 0.5 micro N over the range of 1 to 100 micro N.
DTIC
Computer Techniques; Resonance; Electromagnets; Pulsed Plasma Thrusters; Plasma Engines

76
SOLID-STATE PHYSICS

Includes condensed matter physics, crystallography, and superconductivity. For related information see also *33 Electronics and Electrical Engineering*; and *36 Lasers and Masers*.

20030060464 Pacific Northwest National Lab., Richland, WA, USA
PNNL/Euratom Glass Fiber Optic, Spent Fuel Neutron Profile Measurement System
Bowyer, S. M.; Smart, J. E.; Sep. 1999; 38 pp.; In English
Report No.(s): DE2003-15002685; PNNL-13003; No Copyright; Avail: Department of Energy Information Bridge

Discussions between Euratom and PNNL revealed a need for a neutron detection system that could measure the neutron profile down the entire length of a CASTOR in one measurement. The CASTORS (dry storage casks for spent fuel and vitrified wastes) are roughly 6 meters high and 2 x 2 meters square in cross section. Neutron profiles of the CASTORS are desirable for both content identification and verification. Profile measurements have traditionally been done with He-3 based detectors of about 1 meter high ,that scan the length of a CASTOR as they are lifted by a crane. Geometric reproducibility errors plague this type of measurement and hence, the ability to simultaneously measure the neutron profile over the entire length of the CASTOR became highly desirable. Use of the PNNL developed neutron sensitive glass fibers in the construction of a 6- meter high detector was proposed and design/construction of the detector was completed in August 1999. In-house testing was performed and then the detector was shipped to Gorleben, Germany where it was demonstrated on Castors containing PWR fuel in a dry storage site in September 1999. The resulting data show that the detector demonstration was successful.
NTIS
Nuclear Fuels; Waste Management; Neutron Counters

20030060495 Florida Univ., Gainesville, FL, USA

Investigating Morphological Stability of Faceted Interfaces with Axial Heat Processing (AHP) Technique

Abbaschian, Reza; Balikci, Ercan; Deal, Andrew; Gonik, Michael; Golyshev, Viladimir D.; Leonardi, Eddie; deVahlDavis, G.; Chen, P. Y. P.; Timchenko, V.; 2002 Microgravity Materials Science Conference; February 2003, pp. 1-13; In English; See also 20030060494; Original contains color illustrations

Contract(s)/Grant(s): NASA-450975812; INTAS-ESA-99-01814; No Copyright; Avail: CASI; A03, Hardcopy

Successful processing of homogeneous semiconductor single crystals from their melts depends strongly on precise control of thermal and fluid flow conditions near the solid/liquid interface. In this project, we utilize a novel crystal growth technique called Axial Heat Processing (AHP) that uses a baffle, positioned inside the melt near the interface, to supply and/or conduct heat axially to the interface. The baffle, which may or may not have a heater encased in it, can promote more stable and planar growth as well as reduce buoyancy driven convection. The latter is because the baffle reduces the aspect ratio of the melt as it separates the melt into three sections, above the baffle, in the feed gap between the baffle and the crucible wall, and below the baffle between the baffle base and the interface. AHP also enables a close monitoring and/or control of thermal boundaries near the solid/liquid interface during crystal growth by means of thermocouples placed in the baffle. The interface is kept planar when a heating element in the baffle is used. However, a proper choice of melt height is necessary to keep the interface planar when using the baffle without a heater. This study addresses the influence of melt height and growth velocity on the segregation profile of AHP-grown Sb doped Ge single crystals.

Author

Crystal Growth; Doped Crystals; Liquid-Solid Interfaces; Morphology; Single Crystals; Interface Stability

20030060496 Alabama Univ., Huntsville, AL, USA

Thermophysical Properties of Te-based II-VI Semiconductors: Reduced Algorithms for Thermal Diffusivity Determination

Banish, R. Michael; Brantschen, Segolene; Pourpoint, Timothee L.; Wessling, Francis; Sekerka, Robert F.; 2002 Microgravity Materials Science Conference; February 2003, pp. 53-62; In English; See also 20030060494; Original contains black and white illustrations

Contract(s)/Grant(s): NAG8-1476; NAG8-1704; No Copyright; Avail: CASI; A02, Hardcopy

This paper presents methodologies for measuring the thermal diffusivity using the difference between temperatures measured at two, essentially independent, locations. A heat pulse is applied for an arbitrary time to one region of the sample; either the inner core or the outer wall. Temperature changes are then monitored versus time. The thermal diffusivity is calculated from the temperature difference versus time. No initial conditions are used directly in the final results.

Author

Algorithms; Thermal Diffusivity; Thermophysical Properties; Methodology; Mathematical Models; Semiconductors (Materials); Tellurium

20030060497 Vanderbilt Univ.

The Solidification Velocity of Undercooled Nickel and Titanium Alloys with Dilute Solute

Algoso, Paul R.; Altgilbers, A. S.; Hofmeister, William H.; Bayuzick, Robert J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 63-73; In English; See also 20030060494; Original contains black and white illustrations

Contract(s)/Grant(s): NAG8-1677; No Copyright; Avail: CASI; A02, Hardcopy

The study of solidification velocity is important for two reasons. First, understanding the manner in which the degree of undercooling of the liquid and solidification velocity affect the microstructure of the solid is fundamental. Second, there is disagreement between theoretical predictions of the relationship between undercooling and solidification velocity and experimental results. Thus, the objective of this research is to accurately and systematically quantify the solidification velocity as a function of undercooling for dilute nickel-and titanium-based alloys. The alloys chosen for study cover a wide range of equilibrium partition coefficients, and the results are compared to current theory.

Derived from text

Nickel Alloys; Solidification; Supercooling; Titanium Alloys; Dilution; Velocity Measurement; Containerless Melts; Levitation Melting

20030060498 Massachusetts Inst. of Tech., Cambridge, MA, USA

Kinetic Evolution of Stable and Metastable States of Protein Solutions

Annunziata, Onofrio; Asherie, Neer; Lomakin, Aleksey; Pande, Jayanti; Pande, Ajay; Ogun, Olutayo; Benedek, George B.;

2002 Microgravity Materials Science Conference; February 2003, pp. 104-113; In English; See also 20030060494; No Copyright; Avail: CASI; A02, Hardcopy

The thermodynamic and kinetic properties of protein solutions are important in many industrial, scientific and pathophysiological applications. These applications include the large scale separation of proteins by aqueous two phase partition and the production of crystals of biologically important proteins for the determination of their three-dimensional structure. Protein solutions exhibit phase transformations such as crystallization, metastable liquid-liquid phase separation, aggregation, self assembly and gelation. We have investigated the crystallization and metastable liquid-liquid phase separation (LLPS) in the gamma crystallins, a family of proteins of eye lenses. In crystallization, a solid (crystal) forms from the protein solution. In LLPS, the solution separates into two coexisting liquid phases of unequal protein concentration. This LLPS is brought about by the attractive interactions between the gamma crystallins. Although LLPS is metastable with respect to crystallization, crystal formation in the gamma crystallins is usually slow enough so that the coexistence curve can still be measured. We have analyzed the effect of protein modifications (genetic mutations) and the effect of additives (PEG) on the phase behavior of gamma crystallins aqueous solutions. The formation of new phases is known to be strongly influenced by the phenomena of gravity-driven convection and sedimentation. This is especially true for proteins, since they are large particles with slow kinetic behavior. Under microgravity conditions the effects of convection and sedimentation are greatly reduced, and thus transformations which are usually masked by the presence of gravity can be observed. Microgravity conditions can elucidate the variety of condensed phases possible in protein solutions.

Derived from text

Crystallization; Metastable State; Proteins; Thermodynamic Properties; Aqueous Solutions; Phase Stability (Materials)

20030060499 Illinois Univ. at Urbana-Champaign, Urbana, IL, USA

Dendritic Growth with Fluid Flow for Pure Materials

Jeong, Jun-Ho; Dantzig, Jonathan A.; Goldenfeld, Nigel; 2002 Microgravity Materials Science Conference; February 2003, pp. 139-146; In English; See also 20030060494

Contract(s)/Grant(s): NSF DMS 98-73945; NAG8-1657; No Copyright; Avail: CASI; A02, Hardcopy

We have developed a three-dimensional, adaptive, parallel finite element code to examine solidification of pure materials under conditions of forced flow. We have examined the effect of undercooling, surface tension anisotropy and imposed flow velocity on the growth. The flow significantly alters the growth process, producing dendrites that grow faster, and with greater tip curvature, into the flow. The selection constant decreases slightly with flow velocity in our calculations. The results of the calculations agree well with the transport solution of Saville and Beaghton at high undercooling and high anisotropy. At low undercooling, significant deviations are found. We attribute this difference to the influence of other parts of the dendrite, removed from the tip, on the flow field.

Derived from text

Dendritic Crystals; Finite Element Method; Flow Distribution; Solidification; Crystal Growth

20030060500 Georgia State Univ., Atlanta, GA, USA

Real-Time Optical Monitoring and Simulations of Gas Phase Kinetics in InN Vapor Phase Epitaxy at High Pressure

Dietz, Nikolaus; Woods, Vincent; McCall, Sonya D.; Bachmann, Klaus J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 168-177; In English; See also 20030060494; Original contains color illustrations

Contract(s)/Grant(s): NCC8-95; NAG8-1686; No Copyright; Avail: CASI; A02, Hardcopy

Understanding the kinetics of nucleation and coalescence of heteroepitaxial thin films is a crucial step in controlling a chemical vapor deposition process, since it defines the perfection of the heteroepitaxial film both in terms of extended defect formation and chemical integrity of the interface. The initial nucleation process also defines the film quality during the later stages of film growth. The growth of emerging new materials heterostructures such as InN or In-rich Ga(x)In(1-x)N require deposition methods operating at higher vapor densities due to the high thermal decomposition pressure in these materials. High nitrogen pressure has been demonstrated to suppress thermal decomposition of InN, but has not been applied yet in chemical vapor deposition or etching experiments. Because of the difficulty with maintaining stochiometry at elevated temperature, current knowledge regarding thermodynamic data for InN, e.g., its melting point, temperature-dependent heat capacity, heat and entropy of formation are known with far less accuracy than for InP, InAs and InSb. Also, no information exists regarding the partial pressures of nitrogen and phosphorus along the liquidus surfaces of mixed-anion alloys of InN, of which the InN(x)P(1-x) system is the most interesting option. A miscibility gap is expected for InN(x)P(1-x) pseudobinary solidus compositions, but its extent is not established at this point by experimental studies under near equilibrium conditions. The extension of chemical vapor deposition to elevated pressure is also necessary for retaining stoichiometric single phase surface

composition for materials that are characterized by large thermal decomposition pressures at optimum processing temperatures.
Author
Computerized Simulation; High Pressure; Kinetics; Nucleation; Vapor Phase Epitaxy; Indium Compounds; Optical Properties

20030060503 Kansas State Univ., Manhattan, KS, USA
Twinning, Epitaxy and Domain Switching in Ferroelastic Inclusion Compounds
Hollingsworth, Mark D.; Peterson, Matthew L.; 2002 Microgravity Materials Science Conference; February 2003, pp. 283-288; In English; See also 20030060494; Original contains color illustrations
Contract(s)/Grant(s): NAG8-1702; NSF DMR-96-19191; No Copyright; Avail: CASI; A02, Hardcopy

Our research is in the area of solid-state organic chemistry, which lies at the interface between physical organic chemistry and materials science. We use crystalline solids as models to probe fundamental issues about physical processes, molecular interactions and chemical reactions that are important for fabrication, stabilization and application of technological materials. Much of our most recent work has focused on the phenomena of ferroelastic and ferroelectric domain switching, in which application of an external force or electric field to a crystal causes the molecules inside the crystal to reorient, in tandem, to a new orientational state. To better understand and control the domain switching process, we have designed and synthesized over twenty closely related, ferroelastic organic crystals. Our approach has been to use crystalline inclusion compounds, in which one molecule (the guest) is trapped within the crystalline framework of a second molecule (the host). By keeping the host constant and varying the proportions and kinds of guests, it has been possible to tailor these materials so that domain switching is rapid and reversible (which is desirable for high technology applications). Inclusion compounds therefore serve as powerful systems for understanding the specific molecular mechanisms that control domain switching.
Derived from text
Twinning; Epitaxy; Ferroelectricity; Chemical Reactions; Technology Utilization; Molecular Interactions

20030060504 NASA Glenn Research Center, Cleveland, OH, USA
Data and Modeling of Dendrites Subject to A Step Change in Pressure (TDSE)
Koss, Matthew B.; LaCombe, J. C.; Glicksman, M. E.; Pines, V.; Chait, A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 339-346; In English; See also 20030060494
Contract(s)/Grant(s): NAG8-1488; No Copyright; Avail: CASI; A02, Hardcopy

There is considerable interest in dendritic solidification because of the influence dendrites have in the determination of microstructure, and thereby in the physical properties of cast metals and alloys. Current theories and models of dendritic growth generally couple diffusion effects in the melt with the physics of the interface. Data and subsequent analysis prior of the tip growth speed and radii of thermal succinonitrile dendrites in the near-convection free, on-orbit, free-fall environment demonstrate that these theories yield predictions that are reasonably in agreement with the results of experiment. However, data and analysis for assessing the interfacial physics component of theory are not sufficiently detailed or definitive. To study fundamental aspects of dendritic interface stability, we are measuring and modeling the kinetics and morphology of dendrites as they evolve from one well-defined steady state at a pre-set supercooling, through a transient stage, to a different well-defined steady state. More specifically, we subject succinonitrile dendrites, growing under steady-state conditions, to a rapid change in pressure. This leads to a rapid change in thermal driving force from the corresponding change in both the equilibrium melting temperature due to the Clapeyron effect, and a change in the far-field temperature due to adiabatic temperature changes in the bulk liquid and solid. Subsequently, we observe transformations from a well-characterized initial state into a new steady-state. Initial data reveal that the dendrite tip velocity changes almost as fast as the pressure charges, while the tip radius changes occur more slowly, taking from 10 60 seconds depending on the size of the step change and the final supercooling. Computer modeling of this process shows both agreements and disagreements with the experimental data. In making these observations and measurements, we are gaining new understandings of interfacial dynamics and state-selection physics.
Author
Dendritic Crystals; Solidification; Crystal Growth; Interface Stability; Phase Transformations; Crystal Morphology; Surface Properties

20030060506 Case Western Reserve Univ., Cleveland, OH, USA
Diffusion Processes in Molten Semiconductors (DPIMS): Flight Results from the STS-94/MSL-IR Spacelab Mission
Matthiesen, D. H.; Keefer, L. A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 391; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

The Diffusion Processes in Molten Semiconductors (DPIMS) investigation was a three-part program that sought to: 1) Provide purely diffusive experimental measurements of the isothermal diffusion coefficients of gallium (Ga), antimony (Sb) and silicon (Si) in molten germanium (Ge) with sufficient accuracy and precision to: a) Differentiate between model predictions of the temperature dependence; b) Determine the effect of dopant size and type; c) Determine if a wall effect was present; d) Provide input to continuum model development; and e) Provide input to atomistic model development. 2) Develop a 2-dimensional, fully time dependent continuum numerical model of the germanium diffusion column, shear cell, cartridge and furnace for both earth-based and space-based experiments which accurately predicted the measured concentration profile as a function of distance in the diffusion column. 3) Develop an atomistic model that accurately predicts: a) The purely diffusive isothermal diffusion coefficient of a dopant in a molten semiconductor; b) The temperature dependence of the dopants in molten semiconductors; and c) Developed new empirical potentials useful for predicting other transport properties in molten semiconductor systems. The efforts of the last two years have yielded outstanding results from all three parts of the DPIMS program.
Derived from text
Semiconductors (Materials); Space Transportation System; Spacelab; Continuum Modeling; Melting; Materials Science; Diffusion Coefficient; Space Missions

20030060507 Universities Space Research Association, Huntsville, AL, USA
Control of Melt Convection using Traveling Magnetic Fields
Mazuruk, Konstantin; Grugel, Richard N.; Zubkov, Pavel T.; 2002 Microgravity Materials Science Conference; February 2003, pp. 405-407; In English; See also 20030060494; No Copyright; Avail: CASI; A01, Hardcopy

Applying an axisymmetric traveling magnetic field induces an axial Lorentz body force in the molten, cylindrical zone, during semiconductor crystal growth. This force can be conveniently controlled, in magnitude and in direction, and can benefit crystal growth applications. In particular, it can significantly offset the buoyancy force, which is often responsible for deleterious effects. Basics of this novel technological method as well as new results on the transition to time dependent flow are presented.
Author
Crystal Growth; Magnetic Fields; Melts (Crystal Growth); Semiconductors (Materials); Convection

20030060509 Clarkson Univ., Potsdam, NY, USA
Improved Crystal Quality By Detached Solidification in Microgravity
Regel, Liya L.; Wilcox, William R.; Wang, Yaz-Hen; Wang, Jian-Bin; 2002 Microgravity Materials Science Conference; February 2003, pp. 476-484; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAG8-1482; No Copyright; Avail: CASI; A02, Hardcopy

Many microgravity directional solidification experiments yielded ingots with portions that grew without contacting the ampoule wall, leading to greatly improved crystallographic perfection. Our long term goals have been: (1) To develop a complete understanding of all of the phenomena of detached solidification.; (2) To make it possible to achieve detached solidification reproducibly; (3) To increase crystallographic perfection through detached solidification. We have three major achievements to report here: (1) We obtained a new material balance solution for the Moving Meniscus Model of detached solidification. This solution greatly clarifies the physics as well as the roles of the parameters in the system; (2) We achieved detached solidification of InSb growing on earth in BN-coated ampoules; (3) We performed an extensive series of experiments on freezing water that showed how to form multiple gas bubbles or tubes on the ampoule wall. However, these did not propagate around the wall and lead to fully detached solidification unless the ampoule wall was extremely rough and non-wetted.
Author
Drying; Directional Solidification (Crystals); Crystallography; Crystal Defects; Microgravity; Phase Transformations

20030060510 California Inst. of Tech., Pasadena, CA, USA
Measurement of Thermophysical Properties of Molten Silicon and Germanium
Rhim, Won-Kyu; 2002 Microgravity Materials Science Conference; February 2003, pp. 485-492; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy

As demands for larger and higher quality semiconductor crystals increase, it has become very important for crystal growers to understand and to control the formation kinetics of a variety of defects such as point defects, non-uniform distribution of doping atoms, and impurity atoms in the growing crystals. However, in a crystal growth environment where

accurate thermophysical properties are lacking, it is difficult to expect reliable results from modeling efforts. Importance of accurate thermophysical properties for crystal growth cannot be overly emphasized. The total hemispherical emissivity of a melt, for instance, has a dramatic impact on the thermal environment. It determines radiative emission from the surface of melts, which, in turn determines to a large extent the profile of solidified crystals. In order to understand convection and turbulence in a melt, knowledge on accurate liquid viscosity is important. Liquid surface tension is also important since it determines the shape of the liquid-atmosphere interface near the solid/liquid-atmosphere triple point. The main objective of this program is in measuring thermophysical properties of molten silicon, germanium, and Si-Ge alloys in the ground base using an electrostatic levitator (ESL) and in identifying areas where the gravity plays limiting roles in measured properties. With limiting areas well identified it is hoped to conduct property measurements in the extended microgravity environment that will be provided by the International Space Station (ISS).
Derived from text
Thermophysical Properties; Silicon; Silicon Alloys; Germanium; Thermal Conductivity; Density Measurement; Interfacial Tension

20030060522 NASA Marshall Space Flight Center, Huntsville, AL, USA
Crystal Growth of ZnSe and Related Ternary Compound Semiconductors by Vapor Transport
Su, Ching-Hua; Brebrick, R. F.; Burger, A.; Dudley, M.; Ramachandran, N.; 2002 Microgravity Materials Science Conference; February 2003, pp. 597-603; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

The objective of the project is to determine the relative contributions of gravity-driven fluid flows to the compositional distribution, incorporation of impurities and defects, and deviation from stoichiometry observed in the crystals grown by vapor transport as results of buoyance-driven convection and growth interface fluctuations caused by irregular fluid-flows. ZnSe and related ternary compounds, such as ZnSeS and ZnSeTe, were grown by vapor transport technique with real time in-situ non-invasive monitoring techniques. The grown crystals were characterized extensively to correlate the grown crystal properties with the growth conditions.
Author
Crystal Growth; Semiconductors (Materials); Ternary Systems; Zinc Selenides; Zinc Tellurides

20030060524 Iowa Univ.
Free Dendritic Growth of Succinonitrile-Acetone Alloys with Thermosolutal Melt Convection
Beckermann, Christoph; Li, Ben Q.; 2002 Microgravity Materials Science Conference; February 2003, pp. 74-92; In English; See also 20030060494
Contract(s)/Grant(s): NCC8-199; No Copyright; Avail: CASI; A03, Hardcopy

A stagnant film model of the effects of thermosolutal convection on free dendritic growth of alloys is developed, and its predictions are compared to available earth-based experimental data for succinonitrileacetone alloys. It is found that the convection model gives excellent agreement with the measured dendrite tip velocities and radii for low solute concentrations. However, at higher solute concentrations the present predictions show some deviations from the measured data, and the measured (thermal) Peclet numbers tend to fall even below the predictions from diffusion theory. Furthermore, the measured selection parameter (sigma*) is significantly above the expected value of 0.02 and exhibits strong scatter. It is shown that convection is not responsible for these discrepancies. Some of the deviations between the predicted and measured data at higher supercoolings could be caused by measurement difficulties. The systematic disagreement in the selection parameter for higher solute concentrations and all supercoolings examined, indicates that the theory for the selection of the dendrite tip operating state in alloys may need to be reexamined.
Author
Acetone; Convection; Dendritic Crystals; Solutes; Melts (Crystal Growth); Nitriles; Alloys

20030060525 Iowa Univ., Iowa City, IA, USA
Convection Effects in Three-dimensional Dendritic Growth
Lu, Yili; Beckermann, C.; Karma, A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 93-102; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NCC8-94; No Copyright; Avail: CASI; A02, Hardcopy

A phase-field model is developed to simulate free dendritic growth coupled with fluid flow for a pure material in three dimensions. The preliminary results presented here illustrate the strong influence of convection on the three-dimensional (3D)

dendrite growth morphology. The detailed knowledge of the flow and temperature fields in the melt around the dendrite from the simulations allows for a detailed understanding of the convection effects on dendritic growth.
Author
Convection; Crystal Growth; Dendritic Crystals; Morphology; Three Dimensional Models; Fluid Flow

20030060527 NASA Marshall Space Flight Center, Huntsville, AL, USA
Step Bunch Evolution on Vicinal Faces of KDP
Booth, N. A.; Chernov, A. A.; Vekilov, P. G.; 2002 Microgravity Materials Science Conference; February 2003, pp. 127; In English; See also 20030060494; No Copyright; A01, Hardcopy; Abstract Only; Available from CASI only as part of the entire parent document

For in-situ studies of the formation and evolution of step patterns in solution growth, we have assembled an experimental setup based on Michelson interferometry with the growing crystal surface as one of the reflective surfaces. The device allows data collection over a relatively large area (approximately 4 sq. mm) in situ and in real time during growth. The depth resolution is improved over traditional interferometry using phase-shifted images combining by a suitable algorithm. We achieve a depth resolution of approximately 50 Angstroms. Lateral resolution, dependent on the degree of magnification, is around 0.3 to 5 microns. The crystal chosen as a model in this work is potassium dihydrogen phosphate (KDP), the optically non-linear material widely used in frequency doubling applications. Kinetics of KDP crystallization is well studied so that KDP can serve as a benchmark for our investigations. We present quantitative results on the onset, initial stages and development of instabilities in moving step trains on vicinal crystal surfaces at varying supersaturation, flow rate, and flow direction. The kinetics data suggest that at low supersaturations, step bunching is caused by impurity retardation of the steps, while at higher supersaturations, we link the non-linearity during growth to interdependence of the velocity and density of the steps evidenced in independent experiments. The behavior on the surface is very dynamic, small bunches both merge and split from larger bunches as they travel across the facet. We present evidence that despite these dynamics, under steady conditions there exists a limiting value to step bunch height. This height is reached at distances between 600 and 1000 microns from the step source. In our experiments, we observed the retention of this step bunch height limit up to the path of 1500 microns.
Author
Potassium Phosphates; Crystallization; Algorithms; Crystal Surfaces; Kinetics

20030060529 Missouri Univ., Rolla, MO, USA
Kinetics of Nucleation and Crystal Growth in Glass Forming Melts in Microgravity
Day, Delbert E.; Ray, Chandra S.; 2002 Microgravity Materials Science Conference; February 2003, pp. 147-154; In English; See also 20030060494; Original contains black and white illustrations
Contract(s)/Grant(s): NAG8-1465; No Copyright; Avail: CASI; A02, Hardcopy

This flight definition project has the specific objective of investigating the kinetics of nucleation and crystal growth in high temperature inorganic oxide, glass forming melts in microgravity. It is related to one1 of our previous NASA projects that was concerned with glass formation for high temperature containerless melts in microgravity. The previous work culminated in two experiments which were conducted aboard the space shuttle in 1983 and 1985 and which consisted of melting (at 1500 C) and cooling levitated 6 to 8 mm diameter spherical samples in a Single Axis Acoustic Levitator (SAAL) furnace. Compared to other types of materials, there have been relatively few experiments, 6 to 8, conducted on inorganic glasses in space. These experiments have been concerned with mass transport (alkali diffusion), containerless melting, critical cooling rate for glass formation, chemical homogeneity, fiber pulling, and crystallization of glass forming melts. One of the most important and consistent findings in all of these experiments has been that the glasses prepared in microgravity are more resistant to crystallization (better glass former) and more chemically homogeneous than equivalent glasses made on earth (1g). The chemical composition of the melt appears relatively unimportant since the same general results have been reported for oxide, fluoride and chalcogenide melts. These results for space-processed glasses have important implications, since glasses with a higher resistance to crystallization or higher chemical homogeneity than those attainable on earth can significantly advance applications in areas such as fiber optics communications, high power laser glasses, and other photonic devices where glasses are the key functional materials. The classical theories for nucleation and crystal growth for a glass or melt do not contain any parameter that is directly dependent upon the g-value, so it is not readily apparent why glasses prepared in microgravity should be more resistant to crystallization than equivalent glasses prepared on earth. Similarly, the gravity-driven convection in a fluid melt is believed to be the primary force field that is responsible for melt homogenization on earth. Thus, it is not obvious why a glass prepared in space, where gravity-driven convection is ideally absent, would be more chemically homogeneous than a glass identically prepared on earth. The primary objective of the present research is to obtain experimental data for the nucleation rate and crystal growth rate for a well characterized silicate melt (lithium disilicate) processed entirely in space (low

gravity) and compare these rates with the nucleation and crystal growth rates for a similar glass prepared identically on earth (1g).
Derived from text
Glass; Kinetics; Melts (Crystal Growth); Microgravity; Nucleation

20030060532 Minnesota Univ., Minneapolis, MN, USA
First Principles Calculations of Liquid II-VI Compounds At Temperatures Above and Below Their Melting Points
Derby, Jeffrey J.; Jain, Manish; Chelikowsky, James R.; 2002 Microgravity Materials Science Conference; February 2003, pp. 168; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

This presentation will highlight results obtained from quantum mechanical molecular dynamics simulations of the liquid state of several II-VI tellurium-containing compounds, notably CdTe and ZnTe. These materials are employed in a variety of technologically important electronic and electrooptical devices; however, their growth has typically proven to be extremely difficult. We seek to obtain a more fundamental understanding of the properties of these compounds so that the physical mechanisms responsible for growth can be elucidated. Our simulations use the pseudopotential density functional method (PDFM) to calculate quantum forces in the melt. We prepare a liquid state ensemble using supercells and Langevin dynamics to thermalize the liquid. One of the most interesting issues in these materials concerns the conductivity of the liquid state. Most Group IV and III-VI semiconductors are metallic in the liquid state; however, some II-VI semiconductors remain semiconducting in the melt. In order to examine this problem in more detail, we have calculated the conductivity of a prototypical III-V semiconductor (GaAs) and compared its properties to II-VI semiconductors. Our demonstration illustrates the microstructure of the liquid state and the self-diffusion of different species within the melt. We will also discuss why it may be difficult to grow Te-containing II-VI s from the melt.
Author
Melting Points; Quantum Mechanics; Semiconductors (Materials); Molecular Dynamics; Temperature Dependence; Liquids

20030060533 Michigan State Univ., East Lansing, MI, USA
Numerical and Experimental Investigation of the Solidification of A Bottom Chilled Cavity
Lum, C.; Shaffi, M.; Koochesfahani, M.; Diaz, A. R.; McGrath, J. J.; Benard, Andre; 2002 Microgravity Materials Science Conference; February 2003, pp. 103; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

The solidification of a bottom-chilled cavity filled with ammonium chloride is investigated in this work. The velocity field near the mushy region is measured and compared to computed results to improve on porosity models. This investigation also attempts to determine the suitability of two novel techniques, one experimental and one numerical, for studying solidification processes. A finite element/fictitious domain method is implemented to evaluate the performance of this approach for solidification problems. Experimental investigations to measure the velocity fields at various instants are carried out using Molecular Tagging Velocimetry (MTV). The fictitious domain method is well suited for rapid design since it eliminates the need for a boundary conforming mesh. In this technique, the domain of the original problem is extended to a larger and simpler auxiliary domain with periodic boundary conditions. Lagrange multipliers are then used to enforce the original boundary conditions. This approach gives rise to efficient numerical scheme, but increases the memory requirements. Simple problems are solved to illustrate the methodology. The MTV method was used to measure the velocity field directly above the chimneys and the adjacent mushy zone. Efforts are currently underway to measure both temperature (using laser induced fluorescence or LIF) and velocity fields simultaneously, as well as reducing the cavity size. The use of MTV/LIF will provide novel experimental results spanning various cavity sizes and chilled configurations. This will demonstrate the capabilities of the MTV/LIF method, provide verification of the modeling approaches proposed, and provide benchmark velocity and temperature field data valuable to other analytical and numerical studies, as well as enhance our understanding of thermo-solutal convection processes. Efforts to obtain micro-scale field measurements around the mushy zone are currently under way.
Author
Ammonium Chlorides; Cavities; Solidification; Numerical Analysis; Methodology

20030060534 North Carolina State Univ., Raleigh, NC, USA
Nanotube-based Structures for Superstrong Materials, Nanoscale Sensors and Devices, and Efficient Electron Emitters
Bernholc, Jerry; Roland, C.; Nardelli, M. Buongiorno; Lu, W.; Meunier, V.; Zhao, Q.; 2002 Microgravity Materials Science

Conference; February 2003, pp. 114-124; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Carbon nanotubes are one of the most interesting new materials to emerge in the past decade, due to their outstanding mechanical and electrical properties. We have predicted, through large-scale ab initio simulations, that they are both incredibly elastic and the strongest materials known. These results have already been confirmed experimentally. However, our most recent calculations, which investigated the atomic transformations leading to fracture, found that the ultimate strength of nanotubes is substantially greater than the one observed experimentally, because in atomically perfect tubes these transformations are hindered by very large barriers. Due to their strength, low specific weight, and unusual electronic properties, nanotube-based materials will enable a variety of unique space and terrestrial applications: in superstrong fibers and composites, as strain and molecular sensors, in novel field emitters, and ultimately in nanoscale electronic devices. Our most recent investigations focus on battery applications, pyro- and piezo-electric nanotubes, and nanotube-cluster assemblies for chemical sensors. Our dynamical simulations of Li diffusion show that Li ions are highly mobile inside carbon nanotube ropes and do not exhibit correlated motion even at fairly high concentrations, indicating the suitability of nanotube/Li materials for very high capacity batteries. Turning to pyroelectric effects, we have shown that most BN nanotubes exhibit a large, built-in electric field along the nanotube axis, as well as large piezoelectric coefficients. Our results show that BN nanotubes will be excellent components of nanotube-based nanoelectro-mechanical systems (NEMS), including actuators, switches, and transducers.

Derived from text

Carbon Nanotubes; Emitters; Mechanical Properties; Sensors; Electromechanical Devices; Nanotechnology; Quantum Mechanics

20030060535 California Inst. of Tech., Pasadena, CA, USA

Dispersion Microstructure and Rheology in Ceramics Processing

Brady, J. F.; 2002 Microgravity Materials Science Conference; February 2003, pp. 125; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Ceramics provide a potentially very useful class of materials owing to their physical properties; they are light, hard, resistant to abrasion, chemically inert, stable at high temperatures, and excellent thermal and electrical insulators. Further, by casting from a liquid suspension and subsequently sintering, many complex parts and shapes can be fabricated. Although the resultant properties of ceramics can be outstanding, they often suffer from extreme brittleness, caused by the propagation of cracks, which is in turn due to microstructural defects. These defects may be caused by a number of different factors, such as particle agglomeration, migration or segregation prior to sintering, or due to inhomogeneous volume change upon sintering. Typically, high-performance ceramics are produced using monodisperse micron-sized particulate suspensions from which the ceramics are cast. By controlling the size and processing, a dense uniform microstructure may be formed prior to sintering. This route has met with limited success even though the maximum volume fraction of ceramic particulates that can be achieved prior to sintering is 0.74. The limited success may stem from the fact that a perfect crystal of mono-sized particles has slip planes that yield easily, and from the fact that there is still a large amount of void space that must be eliminated upon sintering. An alternate approach is to use a mixture of particle sizes. We have developed a new O(N ln N) simulation method with full hydrodynamics Accelerated Stokesian Dynamics to study the microstructure and determine the macroscopic properties of colloidal dispersions used in ceramics processing.

Derived from text

Ceramics; Microstructure; Rheology; Sintering; Dispersions; Crystallization

20030060542 Northeastern Univ., Boston, MA, USA

Phase-Field Simulations of Three-dimensional Dendritic Growth at Low Undercooling

Karma, Alain; Plapp, Mathis; 2002 Microgravity Materials Science Conference; February 2003, pp. 320-326; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Commercial metallic alloys often freeze dendritically. The microstructure that results from this nonequilibrium process controls the properties of the final solidification product. Moreover, dendritic growth has been of fundamental interest to physicists in the general context of pattern formation in nonequilibrium dissipative systems. Even though dendrites have been studied for decades, our present understanding of the growth of these structures remains in many cases uncertain and/or qualitative. Sharp-interface theories have been developed that make explicit predictions for: (1) the tip steady-state operating state (tip velocity V and tip radius rho), (2) the three-dimensional tip morphology, and (3) the formation of secondary branches (sidebranching). These theories, however, generally assume that the transport in the melt is purely diffusive, whereas dendrite growth in terrestrial experiments is strongly influenced by convection. For this reason, the predictive capability of these

theories has remained largely untested. Recent advances in the phase-field method have created a unique opportunity to accurately test these theories. This method has the well-known advantage that it avoids front-tracking by the use of a scalar field that distinguishes between solid and liquid. Improved phase-field formulations and efficient algorithms are now making it possible to simulate dendrite growth in three dimensions, in both transient and steady-state growth regimes. In this report, we summarize the recent progress made in using state-of-the-art phase-field simulations to test accurately the predictions of sidebranching theories based on noise amplification, as well as to investigate whether thermal noise of microscopic origin suffices to produce the experimentally observed sidebranching activity.
Author
Three Dimensional Models; Dendritic Crystals; Crystal Growth; Supercooling

20030060543 NASA Marshall Space Flight Center, Huntsville, AL, USA
Studies of Nucleation and Growth, Specific Heat and Viscosity of Undercooled Melts of Quasicrystal and Polytetrahedral-Phase Forming Alloys
Kelton, K. F.; Gangopadhyay, Anup K.; Lee, G. W.; Hyers, Robert W.; Rathz, T. J.; Robinson, Michael B.; Rogers, Jan R.; 2002 Microgravity Materials Science Conference; February 2003, pp. 327-337; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

From extensive ground based work on the phase diagram and undercooling studies of Ti-Zr-Ni alloys, have clearly identified the composition of three different phases with progressively increasing polytetrahedral order such as, (Ti/Zr), the C14 Laves phase, and the i-phase, that nucleate directly from the undercooled liquid. The reduced undercooling decreases progressively with increasing polytetrahedral order in the solid, supporting Frank s hypothesis. A new facility for direct measurements of the structures and phase transitions in undercooled liquids (BESL) was developed and has provided direct proof of the primary nucleation of a metastable icosahedral phase in some Ti-Zr-Ni alloys. The first measurements of specific heat and viscosity in the undercooled liquid of this alloy system have been completed. Other than the importance of thermo-physical properties for modeling nucleation and growth processes in these materials, these studies have also revealed some interesting new results (such as a maximum of C(sup q, sub p) in the undercooled state). These ground-based results have clearly established the necessary background and the need for conducting benchmark nucleation experiments at the ISS on this alloy system.
Derived from text
Melts (Crystal Growth); Nucleation; Specific Heat; Viscosity; Phase Transformations

20030060547 Purdue Univ., West Lafayette, IN, USA
Different Rule Sets for Cellular Automata Modeling of Peritectic Dendritic Growth
Raghavan, Srinivasan; Krane, Matthew John M.; Johnson, David; 2002 Microgravity Materials Science Conference; February 2003, pp. 298-306; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Peritectic alloys display a wide variety of growth morphologies from coarse dendritic microstructures to finer two-phase microstructures suggesting coupled growth. Lee and Verhoeven noted that a finely spaced cellular-like microstructure formed during directional solidification of a peritectic Ni-Ni3Al alloy. For large G/V growth conditions, the familiar banded microstructure formed. However, at moderate G/V conditions (but still in the range for planar growth as originally defined by Boettinger), a type of coupled growth occurred. This structure consisted of cells of Ni3Al surrounded by a Ni solid solution, with the growth front terminating at a sharp isothermal interface. Lee and Verhoeven termed this microstructure cellular coupled growth. Another example of coupled growth has been reported by Li et al for a Zn-rich Zn-Cu alloys. Here, the resultant microstructure consisted of primary dendrites of CuZn5 and a lamellar matrix consisting of CuZn5 and solid-solution Zn. The primary goal of our research is to explain the morphological development of two-phase peritectic alloys by coupled experimental and numerical procedures. Towards this end, the present paper reports the development of a cellular automaton (CA) model that will be used to predict the growth morphology of peritectic alloys. The preliminary model considers only dendritic growth of the primary phase as governed by a physically realistic set of rules. This paper will describe the development of those rules. The current model will serve as a building block for further work on two-phase peritectic solidification. The Zn-rich Zn-Cu alloys were chosen for the numerically simulations as Ma et al. have recently developed a solidification microstructure selection map for these peritectic alloys. Modeling of dendrites by CA technique has been carried out by many investigators. Brown and Spittle modeled the growth using special rules to represent the heat transport, curvature and liquid-solid transformation. Dilthey and Pavlik modeled the growth considering the effects of curvature and anisotropic surface tension. They modeled the growth of dendrites under different processing conditions and qualitatively compared the results to experiments. The present two dimensional model simulates dendritic growth by allowing a planar solid-liquid

interface to break into cells and dendrites due the presence of constitutional supercooling. Morphological instabilities are due solely to solutal effects. The stabilizing effects of surface tension and curvature at the solid-liquid interface are also considered. Different sets of growth rules are examined for their ability to grow qualitatively reasonable results.
Author
Dendritic Crystals; Crystal Growth; Automata Theory; Morphology; Two Dimensional Models; Solidification

20030060551 NASA, Washington, DC, USA
Defect, Kinetics and Heat Transfer of CDTE Bridgman Growth without Wall Contact
Larson, D. J., Jr.; Zhang, H.; 2002 Microgravity Materials Science Conference; February 2003, pp. 354-365; In English; See also 20030060494; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAG8-1700; No Copyright; Avail: CASI; A03, Hardcopy

A detached growth mechanism has been proposed, which is similar to that proposed by Duffar et al. and used to study the current detached growth system. From numerical results, we can conclude that detached growth will more likely appear if the growth and wetting angles are large and meniscus is flat. Detached thickness is dependent on growth angle, wetting angle, and gap width and shape of the fins. The model can also explain why the detached growth will not happen for metals in which the growth angle is almost zero. Since the growth angle of CdZnTe cannot be changed, to promote detached growth, the number density of the fins should be low and the wetting angle should be high. Also, a much smaller gap width of the fins should be used in the ground experiment and the detached gap width is much smaller. The shape of the fins has minor influence on detached growth. An integrated numerical model for detached solidification has been developed combining a global heat transfer sub-model and a wall contact sub-model. The global heat transfer sub-model accounts for heat and mass transfer in the multiphase system, convection in the melt, macro-segregation, and interface dynamics. The location and dynamics of the solidification interface are accurately tracked by a multizone adaptive grid generation scheme. The wall contact sub-model accounts for the meniscus dynamics at the three-phase boundary. Simulations have been performed for crystal growth in a conventional ampoule and a designed ampoule to understand the benefits of detached solidification and its impacts on crystalline structural quality, e.g., stoichiometry, macro-segregation, and stress. From simulation results, both the Grashof and Marangoni numbers will have significant effects on the shape of growth front, Zn concentration distribution, and radial segregation. The integrated model can be used in designing apparatus and determining the optimal geometry for detached solidification in space and on the ground.
Derived from text
Bridgman Method; Heat Transfer; Kinetics; Mathematical Models; Cadmium Tellurides; Crystal Growth; Crystal Defects; Defects

20030060552 NASA Glenn Research Center, Cleveland, OH, USA
Magnetic Field Effects on Convection and Solidification in Normal and Microgravity
Li, Ben Q.; deGroh, H. C., III; 2002 Microgravity Materials Science Conference; February 2003, pp. 367-379; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

It has been well understood that convective flows induced by g-jitter forces associated with spacecraft are responsible for defects formation and irregularity in product quality during melt growth of single crystals in microgravity. This research is concerned about numerical simulations and experimental measurements for the purpose of developing a fundamental understanding of the g-jitter induced fluid flows and their effects on solidification in microgravity with and without the presence of additional damping forces that are derived from the applied DC magnetic fields. The numerical models include both 2-D and 3-D transient fluid flow, heat transfer, mass transfer and solidification under the combined action of g-jitter and magnetic fields. Numerical simulations using both the 2-D and 3-D models are conducted for both idealized, synthesized and real g-jitter forces, and 2-D simulations are tested against the experimental measurements taken on the thermal oscillator. 2-D solidification models have also been developed and simulations are conducted. Results show that the numerical model predictions compare well with the measurements. Analysis of these results illustrates that an applied magnetic field can have a drastic influence on the convective flows induced by g-jitter and can be particularly useful to suppress the effects resulting from the spiking of g-jitter signatures, which are considered the most detrimental effects on quality of crystals grown in space. Work in progress includes developing 3-D numerical models for solidification phenomena with the presence of both g-jitter and magnetic fields and measurements of flow fluid and its effect on solidification in both transparent fluid and low melting point melts to verify numerical predictions.
Author
Damping; Convective Flow; Solidification; Levitation; Direct Numerical Simulation; Magnetic Fields; Magnetic Effects; Mathematical Models

20030060553 North Carolina State Univ., Raleigh, NC, USA

Models of Mass Transport During Microgravity Crystal Growth of Alloyed Semiconductors in a Magnetic Field

Ma, Nancy; 2002 Microgravity Materials Science Conference; February 2003, pp. 380-382; In English; See also 20030060494; No Copyright; Avail: CASI; A01, Hardcopy

Alloyed semiconductor crystals, such as germanium-silicon (GeSi) and various II-VI alloyed crystals, are extremely important for optoelectronic devices. Currently, high-quality crystals of GeSi and of II-VI alloys can be grown by epitaxial processes, but the time required to grow a certain amount of single crystal is roughly 1,000 times longer than the time required for Bridgman growth from a melt. Recent rapid advances in optoelectronics have led to a great demand for more and larger crystals with fewer dislocations and other microdefects and with more uniform and controllable compositions. Currently, alloyed crystals grown by bulk methods have unacceptable levels of segregation in the composition of the crystal. Alloyed crystals are being grown by the Bridgman process in space in order to develop successful bulk-growth methods, with the hope that the technology will be equally successful on earth. Unfortunately some crystals grown in space still have unacceptable segregation, for example, due to residual accelerations. The application of a weak magnetic field during crystal growth in space may eliminate the undesirable segregation. Understanding and improving the bulk growth of alloyed semiconductors in microgravity is critically important. The purpose of this grant to to develop models of the unsteady species transport during the bulk growth of alloyed semiconductor crystals in the presence of a magnetic field in microgravity. The research supports experiments being conducted in the High Magnetic Field Solidification Facility at Marshall Space Flight Center (MSFC) and future experiments on the International Space Station.

Derived from text

Crystal Growth; Magnetic Fields; Mass Transfer; Microgravity; Semiconductors (Materials); Alloying; Mathematical Models

20030060554 Utah Univ., Salt Lake City, UT, USA

Novel Microstructures For Polymer-Liquid Crystal Composite Materials

Magda, J. J.; Smith, G. D.; Tian, Pu; Ramanathan, K.; Kim, H.; Glaser, M. A.; Clark, N. A.; Bowman, C.; Radzihovsky, L.; Nagel, S., et al.; 2002 Microgravity Materials Science Conference; February 2003, pp. 383-389; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

An understanding of the factors that control the orientation of liquid crystal (LC) molecules at interfaces is of great scientific as well as practical interest. The behavior of liquid crystals at interfaces is key to the performance of current and proposed optical devices such as flat panel displays, switchable light panels, and photonic band gap materials for optical beam steering. In flat panel liquid crystal displays, the grey scale contrast is controlled by the 'pre-tilt angle', which is the out-of-plane angle between the LC molecules and the inner surface of the display window. The pre-tilt angle varies widely among different liquid crystal-forming materials, and depends in a subtle and unknown way upon the chemical structure of the molecules. This means that little guidance can be given to chemists in their attempts to synthesize new types of liquid crystals. Efforts to exploit the anisotropic optical properties of liquid crystals in switchable light panels has been pursued in the context of the so-called polymer dispersed liquid crystals (PDLCs), biphasic materials in which micron-sized droplets of minority phase liquid crystals are dispersed in a polymer matrix. Recently, we have proposed that a novel family of polymer/liquid crystal composite materials formed under microgravity conditions may be more suitable, namely dispersions of polymer colloidal particles in liquid crystal media (liquid crystal dispersed colloids, or LCDCs). For both PDLCs and LCDCs, a significant volume fraction of the materials is associated with the interfacial region between the two phases. Here again control over the polymer/liquid crystal interface is key to the optimization of electro-optic properties. These considerations have led us to adopt a coordinated experimental and molecular simulation approach to the study of liquid crystals at interfaces. In order to predict the effect of chemical structure on interfacial behavior, we use the powerful computational technique of molecular dynamics simulations. In this technique, one chooses a priori a coarse-grained molecular model for the liquid crystal, incorporating values for important liquid crystal parameters such as molecular shape and flexibility. For a given molecular model, the classical equations of motion are rigorously solved to obtain the phase diagram and the interfacial properties. In our approach, we fine-tune the molecular model by comparing the interfacial properties obtained from the simulations with experimental measurements of the surface tension. In this way we obtain an accurate molecular model for a given liquid crystal, which can then be used for intelligent design of LCDCs or PDLCs.

Author

Microstructure; Composite Materials; Polymers; Liquid Crystals; Molecular Dynamics

20030060567 Ohio State Univ., Columbus, OH, USA

Inter-Diffusion in PbO-SiO2 Melts: Effect of Free Convection

Gupta, Prabhat K.; He, Yirong; 2002 Microgravity Materials Science Conference; February 2003, pp. 281; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Understanding the kinetics of a variety of technologically important processes such as crystal growth, homogenization, and phase separation requires accurate measurements of the interdiffusion coefficients. Accurate measurements of diffusion coefficients are also needed for developing an understanding of the relationship between the structure and transport properties of liquids and melts. However, earth-based measurements of interdiffusion coefficients in liquids are not easy to perform since diffusion profiles of composition are perturbed by natural convection which is caused by composition induced density changes. The solutal convection cannot be completely eliminated since it is intrinsically linked with compositional changes. One possible solution is to carry out experiments in zero-gravity environment. Another is to quantify and to account for the effect of solutal convection on interdiffusion composition profiles. Several quantitative analyses are available in the literature. To test these theoretical results, it is necessary to generate reliable experimental data in simple binary systems. We have performed experiments in lead silicate super-cooled melts (40 and 50 mol% PbO) since the diffusion profiles can be quenched to room temperature where they can be measured conveniently by electron analytical techniques. Two types of interdiffusion infinite couples with the inter-diffusion direction same as the direction of gravity were annealed at 750 and 850 C for various times. In normal couples, the low density melt (40 mol % PbO) was on top and in inverted couples the high density composition (50 mol % PbO) was on top. No free convection is expected in the normal couples and these profiles can be used to obtain the true values of the diffusion coefficients. Free convection is expected in the inverted couples. The profiles for the inverted couples can be used to test the validity of the models. In all (except one) experiments with inverted couples a complete inversion of the compositions was observed indicating that the Rayleigh-Taylor instability was dominant. The Rayleigh-Taylor instability describes the inversion of two immiscible liquids when the heavier one lies on top. However, one couple did not show inversion and was only in the early stages of Rayleigh-Taylor instability. We were able to measure the composition profiles in this couple at several different locations. The results and analysis of these experiments will be presented.
Author

Melts (Crystal Growth); Lead Oxides; Silicon Dioxide; Diffusion; Free Convection; Diffusion Coefficient; Crystal Growth

20030060569 KLA-Tencor Corp., San Jose, CA, USA

Structure Property Correlations and Phase Transitions in Group IV and III-V Liquids

Krishnan, Shankar; Price, David L.; Saboungi, Marie-Louis; 2002 Microgravity Materials Science Conference; February 2003, pp. 347-353; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Prior molecular dynamics (MD) simulations and laser pulse-heating studies on amorphous Si indicate that Si, Ge, and III-V liquids may undergo a first-order liquid-liquid phase transition [1-3]. For Si and Ge, this transition is predicted in the deeply supercooled liquid. Group III-V and SiGe alloy liquids are expected to exhibit the transition closer to their respective melting temperatures. The MD simulations predict that the transition occurs from the metallic liquid to a tetrahedrally coordinated, viscous and semiconducting liquid. The models also predict a decreasing coordination of Si atoms as the liquid is supercooled towards the transition temperature. However, no direct experimental characterization of the low-coordination phases has been obtained. The purpose of this ground-based research program is to: (1) search for and independently confirm the existence of such first-order transitions, and (2) determine the liquid phase structures. This experimental research program is based on the use of conical nozzle levitation techniques to study the supercooled liquid phases, combined with x-ray diffraction experiments to investigate structural changes in the liquid. The structural results were obtained in four experimental campaigns at the Advanced Photon Source (APS) using the synchrotron x-ray source. Total and partial x-ray structure factors were obtained as a function of temperature and composition over a wide range of Q (momentum transfer) for liquids in the normal and supercooled states. The range of materials studied include silicon, Si-Ge alloys, GaSb, and InSb, YAG, and a number of materials of interest to other NASA PIs. At this conference, results will be present new results on liquid Si, Si-Ge alloys, and GaSb alloys. The present study builds on prior work on liquid Si performed by our research group [4,5] in which we first showed that the first shell coordination and nearest neighbor distances for liquid Si decreased with increased supercooling. This new study builds on this prior finding through measurements at high supercoolings and on SiGe liquids.
Author

Liquid Phases; Molecular Dynamics; Pulse Heating; Amorphous Silicon; Conical Nozzles; Melting

20030060570 Carnegie-Mellon Univ., Pittsburgh, PA, USA

The Influence of the Nucleation Energy Barrier on the Morphological Evolution and Coarsening of Faceted Crystals

Rohrer, Gregory S.; 2002 Microgravity Materials Science Conference; February 2003, pp. 494-504; In English; See also 20030060494; Original contains color illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The theory for the morphological evolution of crystals bound by rough surfaces is well developed. For example, kinetic laws have been established for capillary driven coarsening, thermal groove development, surface flattening, scratch healing,

and shape changes. A key assumption of these theories is that the surfaces are rough. In other words, atoms can be removed from or added to the crystal without an energy barrier so that shape changes can occur at rates determined either by diffusion or by the kinetics of the surface attachment process. In this paper, we consider the situation where the crystal is bound by singular or nonrough surfaces, which correspond to cusps in the plot of surface free energy as a function of orientation. In this case, facets can move in normal directions only when a step propagates across the surface and adds or removes a layer of atoms. If the facet contains no preexisting steps, then a nucleation event is required to provide a propagating step. The requirement for two-dimensional nucleation creates a so-called growth resistance which can only be overcome by either a very high supersaturation or by the presence of a persistent step-generating defect such as a screw dislocation. The purpose of this paper is to demonstrate that this basic difference in the mechanism by which faceted and rough crystals change shape has an important influence on the morphological evolution of crystalline solids. At the out set, we should recognize that the implications of the nucleation requirement for the morphological evolution of faceted crystals in situations where the driving force is low has been recognized by other researchers. Thus, although the potential importance of the nucleation energy barrier (NEB) was recognized by at least some researchers, it was not quantified. As a result, observations of faceted materials have usually been interpreted in terms of kinetic laws appropriate for crystals with rough surfaces, under the assumption that a persistent source of steps is available. This approach is entirely justified, as long as the crystal is large enough (say 10 m) that the presence of a step creating defect is guaranteed. The interesting point here is that for very small crystals, less then a micron in diameter, the presence of a step-generating defect is far less likely and, in these cases, the NEB makes the kinetic laws for crystals with rough surface inappropriate. Considering the growing importance of materials with nanometer scale dimensions, it is interesting to consider the behavior of faceted materials in this size range more carefully.
Author
Crystal Growth; Flat Surfaces; Surface Properties; Coarseness; Crystal Morphology; Nucleation

20030060574 Arizona Univ., Tucson, AZ, USA
Dynamic Biaxial Flexural Strength of Thin Ceramic Substrates
Cheng, Ming; Chen, Weinong; Sridhar, K. R.; 2002 Microgravity Materials Science Conference; February 2003, pp. 576-585; In English; See also 20030060494; Original contains black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

An experimental technique for determining the biaxial flexural strength of thin ceramic substrates at high loading rates has been developed and verified by experiments. The loading configuration is the same as the quasi-static piston-in-3-ball experimental technique, making the high loading rate results directly comparable to the standard quasi-static results. The upper and lower limits of the loading rate range for a valid experiment with a specific specimen were analyzed. new model for dynamic strength under constant high stress-rate loading for brittle materials was developed based on the concept of cumulative damage. The parameters in this model were experimentally identified using an overall least squares curve-fitting technique for all the data at different loading stress rates. Ceramic material 8YSZ and six of its doped compositions with alumina and 3YSZ were tested using standard piston-on-3-ball method under quasi-static loading and a newly developed dynamic piston-on-3-ball method under high stress-rate loading. The experimental results show that the new dynamic strength model for brittle materials describes both the quasi-static strength and the dynamic strength behavior appropriately.
Derived from text
Ceramics; Flexural Strength; Substrates; Dynamic Characteristics; Thin Films

20030060576 NASA Marshall Space Flight Center, Huntsville, AL, USA
Reduction of Defects in Germanium-Silicon
Szofran, Frank R.; Benz, K. W.; Cobb, Sharon D.; Croell, Anne; Dold, P.; Motafef, S.; Schweizer, M.; Volz, Martin P.; Walker, J. S.; 2002 Microgravity Materials Science Conference; February 2003, pp. 612-615; In English; See also 20030060494; No Copyright; Avail: CASI; A01, Hardcopy

Crystals grown without being in contact with a container have superior quality to otherwise similar crystals grown in direct contact with a container, especially with respect to impurity incorporation, formation of dislocations, and residual stress in the crystals. In addition to float-zone processing, detached Bridgman growth, although not a completely crucible-free method, is a promising tool to improve crystal quality. It does not suffer from the size limitations of float zoning and the impact of thermocapillary convection on heat and mass transport is expected to be negligible. Detached growth has been observed frequently during g experiments. Considerable improvements in crystalline quality have been reported for these cases. However, neither a thorough understanding of the process nor a quantitative assessment of the quality of these improvements exists. This project will determine the means to reproducibly grow GeSi alloys in a detached mode and seeks to compare processing-induced defects in Bridgman, detached-Bridgman, and floating-zone growth configurations in GeSi crystals (Si less than or equal to 10 at%) up to 20mm in diameter. Specific objectives include: measurement of the relevant material parameters

such as contact angle, growth angle, surface tension, and wetting behavior of the GeSi-melt on potential crucible materials; determination of the mechanism of detached growth including the role of convection; quantitative determination of the differences in defects and impurities for crystals grown using normal Bridgman, detached Bridgman, and floating zone (FZ) methods; investigation of the influence of a defined flow imposed by a rotating magnetic field on the characteristics of detached growth; control of time-dependent Marangoni convection in the case of FZ growth by the use of a rotating magnetic field to examine the influence on the curvature of the solid-liquid interface and the heat and mass transport; and growth of benchmark quality GeSi-single crystals.

Author

Bridgman Method; Defects; Germanium Alloys; Silicon Alloys; Crystal Growth

20030060578 NASA Glenn Research Center, Cleveland, OH, USA

Surface Tension and Viscosity of SCN and SCN-acetone Alloys at Melting Points and Higher Temperatures Using Surface Light Scattering Spectrometer

Tin, Padetha; deGroh, Henry C., III.; 2002 Microgravity Materials Science Conference; February 2003, pp. 622; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

Succinonitrile has been and is being used extensively in NASA's Microgravity Materials Science and Fluid Physics programs and as well as in several ground-based and microgravity studies including the Isothermal Dendritic Growth Experiment (IDGE). Succinonitrile (SCN) is useful as a model for the study of metal solidification, although it is an organic material, it has a BCC crystal structure and solidifies dendriticly like a metal. It is also transparent and has a low melting point (58.08 C). Previous measurements of succinonitrile (SCN) and alloys of succinonitrile and acetone surface tensions are extremely limited. Using the Surface Light Scattering technique we have determined non invasively, the surface tension and viscosity of SCN and SCN-Acetone Alloys at different temperatures. This relatively new and unique technique has several advantages over the classical methods such as, it is non invasive, has good accuracy and measures the surface tension and viscosity simultaneously. The accuracy of interfacial energy values obtained from this technique is better than 2\% and viscosity about 10 %. Succinonitrile and succinonitrile-acetone alloys are well-established model materials with several essential physical properties accurately known - except the liquid/vapor surface tension at different elevated temperatures. We will be presenting the experimentally determined liquid/vapor surface energy and liquid viscosity of succinonitrile and succinonitrile-acetone alloys in the temperature range from their melting point to around 100 C using this non-invasive technique. We will also discuss about the measurement technique and new developments of the Surface Light Scattering Spectrometer.

Author

Interfacial Tension; Viscosity; Acetone; Spectroscopy; Analogs; Solidification; Metals; High Temperature; Liquid Phases

20030060581 Iowa State Univ. of Science and Technology, Ames, IA, USA

Interface Pattern Selection Criterion For Cellular Structures in Directional Solidification (IPSIDS)

Trivedi, R.; Liu, Shan; Lee, J. H.; Tewari, S. N.; 2002 Microgravity Materials Science Conference; February 2003, pp. 631-642; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The central focus of this flight-definition investigation is to establish key scientific concepts that govern the selection of the interface patterns during the directional solidification of alloys. The critical scientific concepts in the selection of the interface patterns will be addressed first and then the results of the groundbased experimental studies in the Al-Cu alloys will be presented. For directional solidification of an alloy, the key problem is to establish the criteria that dictate the selection of a unique solution, or a certain narrow set of solutions, for cellular and dendritic patterns. The extensive ground-based experiments on the three-dimensional patterns show significant disorder due to the presence of gravity-induced fluid flow, so that microgravity experiments are needed to obtain benchmark data in which gravity-induced fluid flow is negligible. The results of the theoretical model and the parameters to be measured for low gravity experimental data will be discussed to obtain quantitative understanding of the fundamental physics of pattern formation and to establish a reliable theoretical framework for the prediction of the pattern formation. The ground-based results to establish the experimental matrix, to determine the physical constants of the system and to analyze low gravity experiments will be presented. The experimental matrix was determined by developing a new technique in which diffusive growth could be obtained in thin samples, i.e., <phi 1.0 mm for Al-4.0wt%Cu alloys. We have developed new experimental techniques to measure two critical system parameters: anisotropy in interfacial energy and the solute diffusion coefficient in the liquid. The anisotropy for Al-4.0wt%Cu alloy is 0.0098+0.0008 with 95\% confidence interval, which is the first experimentally measured value for nearly isotropic metallic systems. The intrinsic solute diffusion coefficient in liquid was found to be 2.4 10(exp -9) sq m/s, which is significantly smaller than the

previous results that were measured in larger samples (>phi 2.0 mm) and thus were influenced by fluid flow. We have experimentally determined the transient time for steady-state primary arm evolution through three different analyses of the microstructure: Minimum Spanning Tree (MST), Voronoi Polygons and distribution of primary spacings. We also devised the method to analyze the effect of quenching on interface shape and developed the reconstruction techniques for three-dimensional shapes of the array quantitatively analyze flight experimental results on the cell/dendrite shapes.
Author
Aluminum Alloys; Copper Alloys; Directional Solidification (Crystals); Gravitational Effects; Interfacial Energy; Microgravity; Interface Stability; Dendritic Crystals

20030060582 Massachusetts Univ., Amherst, MA, USA
Use of Organic Structure Directing Agents to Control the Morphology of Zeolite Crystals
Tsapatsis, Michael; Vlachos, Dionisios G.; Bonilla, Griselda; Lai, Zhiping; Nery, Jose; 2002 Microgravity Materials Science Conference; February 2003, pp. 655-665; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

Zeolites are crystalline materials with periodic arrangements of cages and channels of nanometer dimensions. Their tailored structure, stability and activity have led to a broad variety of applications in industry as molecular sieves (e.g., gas separation processes), catalysts (e.g. for catalytic cracking in petroleum refining), adsorbents and ion exchangers with high capacities and selectivities. Our research objective focuses on addressing the critical issues of microstructure control in order to develop structure-properties-synthesis relationships for the reproducible fabrication of zeolite membranes. We are also developing models based on the fundamentals of crystal growth, colloidal interactions, and transport phenomena in order to obtain predictive mathematical models that link processing and microstructure with separation performance. Growth rate data and resulting film microstructure from growth in microgravity experiments will be helpful for testing, refining and validating mathematical models for growth, which at this stage of development cannot include gravitational effects due to the poorly understood nature of the crystallizing mixture. In addition, film growth in microgravity will allow clear benchmarking for the practical benefits of the potential for defect elimination when growth takes place in microgravity by comparing the microstructure and the performance in membrane applications for films developed in microgravity with films grown in our lab.
Author
Zeolites; Crystal Morphology; Crystal Growth; Transport Properties; Particle Interactions; Nanostructure (Characteristics); Mathematical Models

20030060583 Containerless Research, Inc., Evanston, IL, USA
Process-Property-Structure Relationships in Complex Oxide Melts
Weber, Richard; Nordine, Paul; 2002 Microgravity Materials Science Conference; February 2003; 5 pp.; In English; See also 20030060494; Original contains color illustrations
Contract(s)/Grant(s): DE-FG02-01ER-86121; W-31-109-eng-38; No Copyright; Avail: CASI; A01, Hardcopy

This project is a fairly broad-based investigation of the behavior of molten oxide materials under highly non-equilibrium conditions accessed using containerless techniques. The work is exploring new directions in materials processing which show promise for development of low gravity experiments requiring pristine liquid surfaces and quiescent liquids to decouple convective and diffusive transport. Emphasis is being placed on investigation of alumina-based materials and the research includes: (i) substituting nitrogen for part of the oxygen in the liquids, (ii) determining glass forming behavior, and (iii) measurement of the structure of the glasses and liquids. Experiments are being performed at CRI and in collaboration with scientists at NASA and NASDA to establish requirements for glass formation and evaluate requirements for measurements of liquid properties, in particular the melt viscosity, using levitation techniques. Collaborations with scientists at Argonne National Laboratory, University of California-Davis and the Food and Drug Administration are providing important information about the structure and properties of the new materials which are resulting from this research. Major activities were: (1) Construction and testing of a high pressure aerodynamic levitator for investigation of oxynitride liquids at pressures up to 5 bar;(2) Synthesis of novel oxide and oxynitride glasses; (3) Establishing conditions for electrostatic levitation of oxide liquids; (4) Investigation of the structure of oxide liquids using neutron diffraction in collaboration with scientists at Argonne National Laboratory.
Author
Aluminum Oxides; Crystal Growth; Oxides; Oxynitrides; Microstructure; Glass; Liquid Surfaces; Interfacial Tension

20030060585 Clarkson Univ., Potsdam, NY, USA

Residual Gas Effects on Detached Solidification in Microgravity

Regel, Liya L.; Wilcox, William R.; Ramakrishnan, Suresh; Kota, Arun; 2002 Microgravity Materials Science Conference; February 2003, pp. 688-694; In English; See also 20030060494; Original contains black and white illustrations

Contract(s)/Grant(s): NAG8-1703; No Copyright; Avail: CASI; A02, Hardcopy

Many microgravity directional solidification experiments yielded ingots with portions that grew without contacting the ampoule wall, leading to greatly improved crystallographic perfection. Our long-term goal is to make such detached solidification reproducible, which requires a full understanding of the mechanisms underlying it. Our Moving Meniscus Model of steady-state detachment predicts that it depends strongly on the surface tension of the melt and the advancing contact angle with the ampoule wall. Detached solidification is more likely when the contact angle for the melt on the ampoule wall is high, i.e. non-wetting. It has been claimed that impurities increase the contact angle. The objective of the current project is to determine the influence of residual gases on the surface tension and contact angle of molten semiconductors on typical ampoule materials. We are focusing on determining the influence of oxygen on the contact angle of molten InSb on clean silica ('quartz'), including the advancing and retreating contact angles in addition to the usual equilibrium contact angle. We have created a gas flow system that allows us to control the oxygen partial pressure over a sessile drop of InSb on a horizontal quartz surface. The cell is slowly tilted while videotaping to reveal the contact angles on the two sides of the drop just prior to it rolling down the surface. Thus far, we have learned the following: (1) Molten InSb readily forms an oxide layer in the presence of the trace amounts of oxygen found in high purity argon; (2) This oxide contains a substantial amount of Ga, which presumably is a trace contaminant that is not detectable in the starting material; (3) The addition of 10\% hydrogen to the argon gas is sufficient to reduce the oxide and produce a clean drop; (4) An infrared filter must precede the video camera in order to produce a sharp image of the drop for later image analysis; (5) Tilting the surface on which the drop rests causes the two sides of the drop to display different contact angles, reflecting contact line sticking; (6) Vibration strongly accelerates the approach of the drop to its final shape on a horizontal surface by helping to overcome sticking of the contact line; (7) Oscillation of the drop surface due to vibration appears to increase as the surface is inclined from horizontal. Presumably, the angle at which the drop rolls down the surface is also reduced by vibration. This observation is particularly significant, as the meniscus must move along the ampoule wall during detached solidification.

Author

Directional Solidification (Crystals); Indium Antimonides; Semiconductors (Materials); Gas Dynamics; Interfacial Tension; Phase Transformations; Oxygen; Drops (Liquids)

20030061101 NASA Marshall Space Flight Center, Huntsville, AL, USA

High Pressure X-Ray Diffraction Studies on Nanocrystalline Materials

Palosz, B.; Stelmakh, S.; Grzanka, E.; Gierlotka, S.; Pielaszek, R.; Bismayer, U.; Werner, S.; Palosz, W.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

Application of in situ high pressure powder diffraction technique for examination of specific structural properties of nanocrystals based on the experimental data of SiC nanocrystalline powders of 2 to 30 nrn diameter in diameter is presented. Limitations and capabilities of the experimental techniques themselves and methods of diffraction data elaboration applied to nanocrystals with very small dimensions (< 30 nm) are discussed. It is shown that due to the complex structure, constituting a two-phase, core/surface shell system, no unique lattice parameter value and, consequently, no unique compressibility coefficient can satisfactorily describe the behavior of nanocrystalline powders under pressure. We offer a tentative interpretation of the distribution of macro- and micro-strains in nanoparticles of different grain size.

Author

X Ray Diffraction; Crystallography; Nanocrystals; Nanostructure (Characteristics); Lattice Parameters

20030061141 NASA Marshall Space Flight Center, Huntsville, AL, USA

Pore Formation and Mobility Investigation (PPMI): Description and Initial Analysis of Experiments Conducted aboard the International Space Station

Grugel, R. N.; Anilkumar, A. V.; Lee, C. P.; [2003]; 1 pp.; In English; Presentation: International Symposium on Physical Sciences in Space (ISPS), 4-8 May 2003, Toronto, Canada; Copyright; Avail: Other Sources; Abstract Only

Flow visualization experiments during the controlled directional melt back and re-solidification of succinonitrile (SCN) and SCN-water mixtures were conducted using the Pore Formation and Mobility Investigation (PFMI) apparatus in the glovebox facility (GBX) aboard the International Space Station. The study samples were initially 'cast' on earth under 450 millibar of nitrogen into 1 cm ID glass sample tubes approximately 30 cm in length, containing 6 in situ thermocouples. During the Space experiments, the processing parameters and flow visualization settings are remotely monitored and

manipulated from the ground Telescience Center (TSC). The ground solidified sample is first subjected to a unidirectional melt back, generally at 10 microns per second, with a constant temperature gradient ahead of the melting interface. Bubbles of different sizes are seen to initiate at the melt interface and, upon release from the melting solid, translate at different speeds in the temperature field ahead of them before coming to rest. Over a period of time these bubbles dissolve into the melt. The gas-laden liquid is then directionally solidified in a controlled manner, generally starting at a rate of 1 micron /sec. Observation and preliminary analysis of bubble formation and mobility in pure SCN samples during melt back and the subsequent structure resulting during gas generation upon re-solidification are presented and discussed.
Author
Flow Visualization; Melts (Crystal Growth); Directional Solidification (Crystals); Phase Transformations; Bubbles; Fluid Flow; Liquid-Solid Interfaces; Gas-Liquid Interactions

20030061229 Consejo Superior de Investigaciones Cientificas, Madrid, Spain, NASA Marshall Space Flight Center, Huntsville, AL, USA
Transport and Growth Kinetics in Microgravity Protein Crystal Growth
Otalora, F.; Garcia-Ruiz, J. M.; Carotenuto, L.; Castagnolo, D.; Novella, M. L.; Chernov, A. A.; [2002]; 1 pp.; In English
Contract(s)/Grant(s): NCC8-66; Copyright; Avail: Other Sources; Abstract Only

The dynamic coupling between mass transport and incorporation of growth units into the surface of a crystal growing from solution in microgravity is used to derive quantitative information on the crystal growth kinetics. To this end, new procedures for experiment preparation, interferometric data processing and model fitting have been developed. The use of experimental data from the bulk diffusive maw transport together with a model for steady state stagnant crystal growth allows the detailed quantitative understanding of the kinetics of both the concentration depletion zone around the crystal and the growth of the crystal interface. The protein crystal used in the experiment is shown to be growing in the mixed kinetic regime (0.2 x 10(exp -6) centimeters per second less than beta R/D less than 0.9 x 10(exp -6) centimeters per second).
Author
Kinetics; Microgravity; Protein Crystal Growth; Transport Properties; Crystal Surfaces

20030061247 NASA Marshall Space Flight Center, Huntsville, AL, USA
Melt-Crucible Wetting Behavior in Semiconductor Melt Growth Systems
Croell, A.; Lantzsch, R.; Kitanov, S.; Salk, N.; Szofran, F. R.; Tegetmeier, A.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources; Abstract Only

The wetting angles of several semiconductor-substrate combinations that are of practical importance for crystal growth have been measured: Ga-GaSb-Sb on fused quartz; Ge on fused quartz and carbon-based substrates, each with different roughness; Si on fused quartz plates and on plates coated with fused quartz, Si3N4, and BN powders. The Ga-GaSb-Sb system showed no significant dependence of the wetting angle on the composition despite a large composition dependence of the surface tension. For Ge, the effect of the roughness on the angle could initially be seen on both types of substrates, but for the fused quartz substrates an equilibrium value independent of the surface treatment was reached after several hours of contact time. For Si, total wetting was found for Si3N4 powders. A reduction of the angle over time was found for both fused quartz and BN powders, with the BN powder showing the highest angle at 150-120 deg.
Author
Wetting; Crystal Growth; Semiconductors (Materials); Melts (Crystal Growth); Angles (Geometry); Substrates; Heating Equipment

20030061418 Michigan Univ., Ann Arbor, MI, USA
Long-Term Reliability of High Speed SiGe/Si Heterojunction Bipolar Transistors
Ponchak, George E., Technical Monitor; Bhattacharya, Pallab; [2003]; 24 pp.; In English
Contract(s)/Grant(s): NAG3-2530; No Copyright; Avail: CASI; A03, Hardcopy

Accelerated lifetime tests were performed on double-mesa structure Si/Si0.7Ge0.3/Si npn heterojunction bipolar transistors, grown by molecular beam epitaxy, in the temperature range of 175C-275C. Both single- and multiple finger transistors were tested. The single-finger transistors (with 5x20 micron sq m emitter area) have DC current gains approximately 40-50 and f(sub T) and f(sub MAX) of up to 22 GHz and 25 GHz, respectively. The multiple finger transistors (1.4 micron finger width, 9 emitter fingers with total emitter area of 403 micron sq m) have similar DC current gain but f(sub T) of 50 GHz. It is found that a gradual degradation in these devices is caused by the recombination enhanced impurity diffusion (REID) of boron atoms from the p-type base region and the associated formation of parasitic energy barriers to

electron transport from the emitter to collector layers. This REID has been quantitatively modeled and explained, to the first order of approximation, and the agreement with the measured data is good. The mean time to failure (MTTF) of the devices at room temperature is estimated from the extrapolation of the Arrhenius plots of device lifetime versus reciprocal temperature. The results of the reliability tests offer valuable feedback for SiGe heterostructure design in order to improve the long-term reliability of the devices and circuits made with them. Hot electron induced degradation of the base-emitter junction was also observed during the accelerated lifetime testing. In order to improve the HBT reliability endangered by the hot electrons, deuterium sintered techniques have been proposed. The preliminary results from this study show that a deuterium-sintered HBT is, indeed, more resistant to hot-electron induced base-emitter junction degradation. SiGe/Si based amplifier circuits were also subjected to lifetime testing and we extrapolate MTTF is approximately 1.1_10(exp 6) hours at 125iC junction temperature from the circuit lifetime data.
Author
Bipolar Transistors; N-P-N Junctions; Semiconductors (Materials); Reliability Analysis; Particle Diffusion; Electron Transfer; Degradation

20030061426 NASA Marshall Space Flight Center, Huntsville, AL, USA
Determination of Nucleation Kinetic Parameters of Metallic Melts Using Electrostatic Levitation Techniques
Wert, M. J.; Hofmeister, W. H.; Bayuzick, R. J.; Rogers, J. R.; Rathz, T. J.; Fountain, G.; Hyers, R. W.; [2002]; 1 pp.; In English; 15th International Symposium on Experimental Methods for Microgravity Materials Science, 6-9 Mar. 2003, San Diego, CA, USA; No Copyright; Avail: Other Sources; Abstract Only

Results from electrostatic levitation studies using zirconium specimens will be presented. Analysis of the data permits the determination of nucleation kinetic parameters.
Author
Melts (Crystal Growth); Levitation Melting; Levitation; Electrostatic Gyroscopes

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PHYSICS OF ELEMENTARY PARTICLES AND FIELDS

Includes quantum mechanics; theoretical physics; and statistical mechanics. For related information see also *72 Atomic and Molecular Physics, 73 Nuclear Physics*, and *25 Inorganic, Organic and Physical Chemistry*.

20030059488 Fermi National Accelerator Lab., Batavia, IL, USA, Northern Illinois Univ., De Kalb, IL, USA
Extrapolation of Supersymmetry-Breaking Parameters to High Energy Scales
Martin, S. P.; Nov. 2002; 10 pp.; In English
Report No.(s): DE2003-804170; FERMILAB-CONF-01/312-T; No Copyright; Avail: Department of Energy Information Bridge

The author studies how well one can extrapolate the values of supersymmetry-breaking parameters to very high energy scales using future data from the Large Hadron Collider and an e(+)e(-) linear collider. He considers tests of the unification of squark and slepton masses in supergravity-inspired models. In gauge-mediated supersymmetry breaking models, he assesses the ability to measure the mass scales associated with supersymmetry breaking. He also shows that it is possible to get good constrains on a scalar cubic stop-stop-Higgs couplings near the high scale. Different assumptions with varying levels of optimism about the accuracy of input parameter measurements are made, and their impact on the extrapolated results is documented.
NTIS
Supersymmetry; Broken Symmetry; High Energy Interactions

20030059500 Argonne National Lab., IL
Target Buffer Assessment for Accelerator Driven Transmuters
Gohar, Y.; 2002; 16 pp.; In English
Report No.(s): DE2003-803899; No Copyright; Avail: Department of Energy Information Bridge

Accelerator driven transmuters use a buffer region to protect the structural and the cladding materials of the transmuter from the radiation damage caused by the high-energy spallation neutrons, to accommodate the coolant channels of the self cooled targets, and to have an insignificant effect on the neutron utilization for the transmutation process. These functions are contradicting with respect to the buffer thickness. An extension of the target region in the axial direction (the proton beam direction) is also required to act as a neutron multiplier for the forward component of the high-energy spallation neutrons and

a reflector to minimize the neutron leakage. The buffer assessment was performed as a function of its thickness with different proton energies for a self-cooled Lead-Bismuth Eutectic and a sodium-cooled tungsten targets. The analyses show that the number of generated neutrons per proton has a low sensitivity to the buffer thickness. However, the number of neutrons reaching the transmuter is significantly reduced as the buffer thickness is increased. The transmuter neutrons dominate the nuclear responses in the structural material outside the target buffer. The length of the axial target extension is determined as a function of the proton beam energy.
NTIS
Transmutation; Buffers; Accelerators

20030059505 Georgia Univ., Athens, GA, USA, Zhejiang Univ., China, Jefferson (Thomas) Lab. Computer Center, Newport News, VA, USA, Tohoku Univ., Sendai, Japan
Bound Nucleon Form Factors, Quark-Hadron Duality, and Nuclear EMC Effect
Tsushima, K.; Lu, D. H.; Melnitchouk, W.; Saito, K.; Thomas, A. W.; 2000; 22 pp.; In English
Report No.(s): DE2003-807186; No Copyright; Avail: Department of Energy Information Bridge

We discuss the electromagnetic form factors, axial form factors, and structure functions of a nucleon bound in the quark-meson coupling (QMC) model. Free space nucleon form factors are calculated using the improved cloudy bag model (ICBM). After describing finite nuclei and nuclear matter in the quark-based QMC model, the in-medium modification of the bound nucleon form factors is calculated in the same model. Finally, the bound nucleon structure function is extracted using the calculated in-medium electromagnetic form factors and Bloom-Gilman (quark-hadron) duality.
NTIS
Quarks; Hadrons; Form Factors; Nucleons

20030061218 NASA Marshall Space Flight Center, Huntsville, AL, USA
Origin of Stability in Particle Sedimentation
Segre, Philip N.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Particle Image Velocimetry (PIV) is used to study the slow settling motions of spheres in suspensions ranging from dilute to highly concentrated, 0.0001 less than phi less than 0.50. During sedimentation, particle velocity fluctuations are found to be organized into regions of characteristic size xi approximately 11 a phi (exp -1/3). A simple model, based upon buoyant mass fluctuations DELTAm given by random density fluctuations in a region of size xi, accurately predicts the magnitudes of the velocity fluctuations DELTAV. We also find a new universal relation for particle diffusion during sedimentation. It can be written in a Stokes-Einstein form as Dapproximately(DELTAmxi)/(6pietaxi), where the effective temperature DELTAmgxi is the gravitational potential energy of density fluctuations. In addition related experiments examining inertial effects and transient states, that are aimed at uncovering the origin of the new lengthscale xi, will also be given.
Author
Particle Image Velocimetry; Sediments; Stability; Particle Diffusion

81
ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

20030061353 NASA Marshall Space Flight Center, Huntsville, AL, USA
NASA's Space Science Programming Possibilities for Planetaria
Adams, M. L.; [2003]; 1 pp.; In English; SEPA 2003, 16-20 Jun. 2003, Baton Rouge, LA, USA; No Copyright; Avail: Other Sources; Abstract Only

The relationship between NASA and the planetarium community is an important one. Indeed, NASA's Office of Space Science has invested in a study of the Space Science Media Needs of Science Center Professionals. Some of the findings indicate a need for exposure to space science researchers, workshops for museum educators, 'canned' programs, and access to a speakers bureau. We will discuss some of the programs of NASA's Sun-Earth Connection Education Forum, distribute sample multimedia products, explain the role of NASA's Educator Resource Center, and review our contributions to NASA's Education and Public Outreach effort.
Author
Planetariums; NASA Programs; Information Dissemination; Multimedia; Public Relations

20030061423 NASA Marshall Space Flight Center, Huntsville, AL, USA

Overview of the SAE G-11 RMSL (Reliability, Maintainability, Supportability, and Logistics) Division Activities and Technical Projects

Singhal, Surendra N.; [2003]; 1 pp.; In English; SAE G11 Division Meeting, 17-19 Feb. 2003, West Palm Beach, FL, USA; No Copyright; Avail: Other Sources; Abstract Only

The SAE G-11 RMSL (Reliability, Maintainability, Supportability, and Logistics) Division activities include identification and fulfillment of joint industry, government, and academia needs for development and implementation of RMSL technologies. Four Projects in the Probabilistic Methods area and two in the area of RMSL have been identified. These are: (1) Evaluation of Probabilistic Technology - progress has been made toward the selection of probabilistic application cases. Future effort will focus on assessment of multiple probabilistic softwares in solving selected engineering problems using probabilistic methods. Relevance to Industry & Government - Case studies of typical problems encountering uncertainties, results of solutions to these problems run by different codes, and recommendations on which code is applicable for what problems; (2) Probabilistic Input Preparation - progress has been made in identifying problem cases such as those with no data, little data and sufficient data. Future effort will focus on developing guidelines for preparing input for probabilistic analysis, especially with no or little data. Relevance to Industry & Government - Too often, we get bogged down thinking we need a lot of data before we can quantify uncertainties. Not True. There are ways to do credible probabilistic analysis with little data; (3) Probabilistic Reliability - probabilistic reliability literature search has been completed along with what differentiates it from statistical reliability. Work on computation of reliability based on quantification of uncertainties in primitive variables is in progress. Relevance to Industry & Government - Correct reliability computations both at the component and system level are needed so one can design an item based on its expected usage and life span; (4) Real World Applications of Probabilistic Methods (PM) - A draft of volume 1 comprising aerospace applications has been released. Volume 2, a compilation of real world applications of probabilistic methods with essential information demonstrating application type and timehost savings by the use of probabilistic methods for generic applications is in progress. Relevance to Industry & Government - Too often, we say, 'The Proof is in the Pudding'. With help from many contributors, we hope to produce such a document. Problem is - not too many people are coming forward due to proprietary nature. So, we are asking to document only minimum information including problem description, what method used, did it result in any savings, and how much?; (5) Software Reliability - software reliability concept, program, implementation, guidelines, and standards are being documented. Relevance to Industry & Government - software reliability is a complex issue that must be understood & addressed in all facets of business in industry, government, and other institutions. We address issues, concepts, ways to implement solutions, and guidelines for maximizing software reliability; (6) Maintainability Standards - maintainability/serviceability industry standard/guidelines and industry best practices and methodologies used in performing maintainability/ serviceability tasks are being documented. Relevance to Industry & Government - Any industry or government process, project, and/or tool must be maintained and serviced to realize the life and performance it was designed for. We address issues and develop guidelines for optimum performance & life.

Author

Probability Theory; Software Reliability; Computer Programs; Logistics; Government/Industry Relations; NASA Programs; Project Management; Technology Assessment

88
SPACE SCIENCES (GENERAL)

Includes general research topics related to the natural space sciences. For specific topics in space sciences see *categories 89 through 93*.

20030060511 Northeastern Univ., Boston, MA, USA

Effect of Gravity Level on the Particle Shape and Size During Zeolite Crystal Growth

Song, Hong-Wei; Ilebusi, Olusegun J.; Sacco, Albert, Jr.; 2002 Microgravity Materials Science Conference; February 2003, pp. 521-530; In English; See also 20030060494; Original contains color and black and white illustrations

Contract(s)/Grant(s): NAG8-1485; No Copyright; Avail: CASI; A02, Hardcopy

A microscopic diffusion model is developed to represent solute transport in the boundary layer of a growing zeolite crystal. This model is used to describe the effect of gravity on particle shape and solute distribution. Particle dynamics and crystal growth kinetics serve as the boundary conditions of flow and convection-diffusion equations. A statistical rate theory is used to obtain the rate of solute transport across the growing interface, which is expressed in terms of concentration and velocity of solute species. Microgravity can significantly decrease the solute velocity across the growing interface compared

to its earth-based counterpart. The extent of this reduction highly depends on solute diffusion constant in solution. Under gravity, the flow towards the crystal enhances solute transport rate across the growing interface while the flow away from crystals reduces this rate, suggesting a non-uniform growth rate and thus an elliptic final shape. However, microgravity can significantly reduce the influence of flow and obtain a final product with perfect spherical shape. The model predictions compare favorably with the data of space experiment of zeolites grown in space.
Author
Zeolites; Crystal Growth; Convection-Diffusion Equation; Microgravity; Spaceborne Experiments; Gravitational Effects

20030060559 NASA Langley Research Center, Hampton, VA, USA
Radiation Transport Properties of Potential In Situ-Developed Regolith-Epoxy Materials for Martian Habitats
Miller, Jack; Heilbronn, Lawrence H.; Zeitlin, Cary J.; Wilson, John W.; Singleterry, Robert C., Jr.; Thibeault, Sheila Ann; 2002 Microgravity Materials Science Conference; February 2003, pp. 427-432; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A02, Hardcopy

Mission crews in space outside the Earth s magnetic field will be exposed to high energy heavy charged particles in the galactic cosmic radiation (GCR). These highly ionizing particles will be a source of radiation risk to crews on extended missions to the Moon and Mars, and the biological effects of and countermeasures to the GCR have to be investigated as part of the planning of exploration-class missions. While it is impractical to shield spacecraft and planetary habitats against the entire GCR spectrum, biological and physical studies indicate that relatively modest amounts of shielding are effective at reducing the radiation dose. However, nuclear fragmentation in the shielding materials produces highly penetrating secondary particles, which complicates the problem: in some cases, some shielding is worse than none at all. Therefore the radiation transport properties of potential shielding materials need to be carefully investigated. One intriguing option for a Mars mission is the use of material from the Martian surface, in combination with chemicals carried from Earth and/or fabricated from elements found in the Martian atmosphere, to construct crew habitats. We have measured the transmission properties of epoxy-Martian regolith composites with respect to heavy charged particles characteristic of the GCR ions which bombard the Martian surface. The composites were prepared at NASA Langley Research Center using simulated Martian regolith, in the process also evaluating fabrication methods which could lead to technologies for in situ fabrication on Mars. Initial evaluation of the radiation shielding properties is made using radiation transport models developed at NASA-LaRC, and the results of these calculations are used to select the composites with the most favorable radiation transmission properties. These candidates are then evaluated at particle accelerators which produce beams of heavy charged particles representative in energy and charge of the radiation at the surface of Mars. The ultimate objective is to develop the models into a design tool for use by mission planners, flight surgeons and radiation health specialists.
Author
Radiation Shielding; Heavy Ions; Galactic Radiation; Cosmic Rays; Radiation Transport

20030060560 Rensselaer Polytechnic Inst., Troy, NY, USA
Space- and Ground-based Crystal Growth Using a Baffle (CGB)
Marin, C.; Cummings, T.; Curilov, A.; Ostrogorsky, A. G.; 2002 Microgravity Materials Science Conference; February 2003, pp. 433; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

CGB is the parent investigation to the Microgravity Science Glovebox Investigation 'SUBSA' which is scheduled for launch on May 31, 2002. The CGB investigation aspires to eliminate buoyancy driven convection and thus enable reproducible diffusion-controlled crystal growth in space and on earth. The key goals are: (i) obtain a better understanding of the role of convection in formation of inhomogeneities and crystalline defects; (ii) explore solidification phenomena that are obscured by convection; (iii) develop models of the transport processes occurring in solidification; (iv) seek explanations for previous space experiments which did not result in the diffusion-controlled segregation; and (v) measure diffusion coefficients of several dopants. The focus of the work presented is modification of the existing SUBSA hardware, to meet the scientific goals of the CGB investigation. These modifications include a motor-driven baffle and a higher temperature in the hot zone, to allow growth of Ge and GaSb. Our numerical simulations indicate that Ge and GaSb crystals can be grown in SUBSA thermal chamber with about 300 W of heating power. Therefore, with small modifications of SUBSA hardware, the scientific goals of the CGB investigation could be realized through re-flight experiments in MSG. Using modified SUBSA hardware for the CGB investigation, would result in a significant reduction in cost and preparation time. To demonstrate that SUBSA hardware can be used for the CGB investigation, a small 'model' ground unit furnace was developed at RPI. The ampoule is driven by a linear stepping motor, using a combination of National Instrument s Lab View and Intelligent Motion System s IM483 micro-stepping driver. Each micro-step results in 0.05 microns of linear displacement, yielding a smooth steady solidification

rate. The baffle is stationary with respect to the thermal chamber, while the ampoule driven linear stepping motor, moves the crystal and the melt relative to the fixed axial gradient. The design of the RPI model furnace and the preliminary experimental results will be presented. This furnace will be used to grow doped Ge and GaSb crystals crystals under terrestrial gravity and under strong magnetic fields.
Author
Convection; Crystal Growth; Baffles; Spaceborne Experiments; Melts (Crystal Growth); Gallium Antimonides; Buoyancy-Driven Flow

20030061149 NASA Marshall Space Flight Center, Huntsville, AL, USA
Laboratory Measurements of Optical Properties of Micron Size Individual Dust Grains
Abbas, M. M.; Craven, P. D.; Spann, J. F.; Tankosic, D.; LeClair, A.; Witherow, W. K.; Camata, R.; Gerakines, P.; [2003]; 1 pp.; In English; Comprehensive International Symposium on Cosmic Dust, 26-29 May 2003, Estes Park, CO, USA; Copyright; Avail: Other Sources; Abstract Only

A laboratory program is being developed at NASA Marshall Space Flight Center for experimental determination of the optical and physical properties individual dust grains in simulated astrophysical environments. The experimental setup is based on an electrodynamic balance that permits levitation of single 0.1 - 10 micron radii dust grains in a cavity evacuated to pressures of approx. 10(exp -6) torr. The experimental apparatus is equipped with observational ports for measurements in the UV, visible, and infrared spectral regions. A cryogenic facility for cooling the particles to temperature of approx. 10-50K is being installed. The current and the planned measurements include: dust charging processes, photoelectric emissions and yields with UV irradiation, radiation pressure measurements, infrared absorption and scattering properties, and condensation processes, involving the analogs of cosmic dust grains. Selected results based on photoemissions, radiation pressure, and other laboratory measurements will be presented.
Author
Dust; Optical Properties; Space Environment Simulation; Electrodynamics; Levitation

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ASTRONOMY

Includes observations of celestial bodies; astronomical instruments and techniques; radio, gamma-ray, x-ray, ultraviolet, and infrared astronomy; and astrometry.

20030059518 NASA Marshall Space Flight Center, Huntsville, AL, USA
Collaborating with Planetaria to Improve Girl Scout's Appreciation of Astronomy
Adams, Mitzi; Phillips, Tony; Whitt, April; [2003]; 1 pp.; In English; 202nd Meeting of the American Astronomical Society, 25-29 May 2003, Nashville, TN, USA
Contract(s)/Grant(s): HST-ED-90231.02-A; No Copyright; Avail: Other Sources; Abstract Only

We have collaborated with two planetaria, Fernbank Science Center's Jim Cherry planetarium in Atlanta, Georgia and the Von Braun Planetarium in Huntsville, Alabama to enhance the appreciation of various astronomical topics among Girl Scouts. Major events sponsored by our partnership were sleepovers in the planetaria during which we studied the total solar eclipse of June 2001 and observed the Eta Aquarid meteor shower of May 2003. Other events included programs on stellar spectroscopy and space physics. As an added inducement for participation, we have sponsored the production of 'pins', which Girl Scouts can earn after satisfying specific requirements. This poster will show samples of the pins, requirements, and online resources for the Girl Scouts.
Author
Astronomy; Planetariums; Solar Eclipses; Astrophysics

20030060466 Lawrence Livermore National Lab., Livermore, CA
Proposed Multiconjugate Adaptive Optics Experiment at Lick Observatory
Bauman, B. J.; Gavel, D. T.; Flath, L. M.; Hurd, R. L.; Max, C. E.; Aug. 15, 2001; 14 pp.; In English
Report No.(s): DE2003-15002889; UCRL-JC-145061; No Copyright; Avail: Department of Energy Information Bridge

While the theory behind design of multiconjugate adaptive optics (MCAO) systems is growing, there is still a paucity of experience building and testing such instruments. We propose using the Lick adaptive optics (AO) system as a basis for

demonstrating the feasibility/workability of MCAO systems, testing underlying assumptions, and experimenting with different approaches to solving MCAO system issues.
NTIS
Adaptive Optics; Feasibility Analysis; Astronomical Observatories; Observatories

20030060628 Johns Hopkins Univ., Baltimore, MD, USA
The Clustering of Galaxies and Dark Matter at Intermediate Redshifts
Jain, Bhuvnesh; Szalay, Alexander; [2003]; 1 pp.; In English
Contract(s)/Grant(s): NAG5-9186; No Copyright; Avail: CASI; A01, Hardcopy

Theoretical work in the study of weak lensing was begun while the Scientific PI (Jain) was at the Johns Hopkins University. A new postdoctoral fellow, Rita Kim, was hired to work for 0.5 years on the proposed research. She was unable to join JHU until March 2001 owing to delays in her PhD work. Meanwhile PI Jain moved to the University of Pennsylvania in January 2001. Owing to the above circumstances, the work for the proposed research was delayed and was expected to be carried out in the remainder of 2001. New measures of lensing based on the magnification effect were to be investigated by Drs. Jain and Kim. The simulations needed to test the analytical computations were already in place; hence the work was expected to proceed fairly rapidly. Owing to the close proximity of JHU and UPenn, the collaborative work was expected to proceed smoothly. It was requested therefore that the funds for the first grant year (2000-2001) be transferred to the second year. Part of the funding was spent at JHU on the salary for the Postdoctoral Fellow, Rita Kim, and the remainder at the University of Pennsylvania. The work from this grant is incomplete and will be continued under another grant.
Author
Dark Matter; Galactic Clusters; Magnification

20030060657 NASA Goddard Space Flight Center, Greenbelt, MD, USA
HST/STIS results on circumstellar disks and jets, future coronography and technology for IR multi-object spectroscopy
Woodgate, Bruce E.; [2002]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Results of studies of circumstellar disks and jets obtained by HST/STIS visible coronagraphy and UV spectroscopy, and by ground-based Fabry-Perot coronagraphy will be presented. Future improvements in coronagraphy will be discussed. The development of microshutter arrays as programmable multi-object selectors for the NGST near IR spectrograph will be described.
Author
Ultraviolet Spectroscopy; Near Infrared Radiation; Coronagraphs; Stellar Envelopes

20030060663 NASA Marshall Space Flight Center, Huntsville, AL, USA
Cluster Masses Derived from X-ray and Sunyaev-Zeldovich Effect Measurements
Laroque, S.; Joy, Marshall; Bonamente, M.; Carlstrom, J.; Dawson, K.; [2003]; 1 pp.; In English; HEAD 2003: Seventh Meeting of the AAS High Energy Astrophysics Division, 23-26 Mar. 2003, Mount Tremblant, Quebec, Canada; No Copyright; Avail: CASI; A01, Hardcopy

We infer the gas mass and total gravitational mass of 11 clusters using two different methods; analysis of X-ray data from the Chandra X-ray Observatory and analysis of centimeter-wave Sunyaev-Zel'dovich Effect (SZE) data from the BIMA and OVRO interferometers. This flux-limited sample of clusters from the BCS cluster catalogue was chosen so as to be well above the surface brightness limit of the ROSAT All Sky Survey; this is therefore an orientation unbiased sample. The gas mass fraction, f_g, is calculated for each cluster using both X-ray and SZE data, and the results are compared at a fiducial radius of r_500. Comparison of the X-ray and SZE results for this orientation unbiased sample allows us to constrain cluster systematics, such as clumping of the intracluster medium. We derive an upper limit on Omega_M assuming that the mass composition of clusters within r_500 reflects the universal mass composition Omega_M h_100 is greater than Omega _B / f-g. We also demonstrate how the mean f_g derived from the sample can be used to estimate the masses of clusters discovered by upcoming deep SZE surveys.
Author
Galactic Clusters; Radio Astronomy; Extraterrestrial Radio Waves; Gamma Ray Astronomy

20030060670 Naval Observatory, Washington, DC, USA
Astrometric Positions and Proper Motions of 19 Radio Stars
Boboltz, D. A.; Fey, A. L.; Johnston, K. J.; Claussen, M. J.; De Vegt, C.; Mar. 18, 2003; 21 pp.; In English
Report No.(s): AD-A412668; No Copyright; Avail: CASI; A03, Hardcopy

We have used the Very Large Army linked with the Pie Town Very Long Baseline Array antenna to determine astrometric positions of 19 radio stars in the International Celestial Reference Frame (ICRF). The positions of these stars were directly linked to the positions of distant quasars though phase referencing observations. The positions of the ICRF quasars are known to 0.25 mas thus providing an absolute reference at the angular resolution of our radio observations. Average values for the errors in our derived positions for all sources were 13 mas and 16 mas in alpha cos delta and delta respectively with accuracies approaching 1-2 mas for some of the stars observed. Differences between the ICRF positions of the 38 quasars and those measured from our observations showed no systematic offsets with mean values of -0.3 mas in alpha cos delta and - 1.0 mas in delta. Standard deviations of the quasar position differences of 17 mas and 11 mas in alpha COS delta and delta respectively are consistent with the mean position errors determined for the stars. Our measured positions were combined with previous Very Large Array measurements taken from l978-l995 to determine the proper motions of 15 of the stars in our list. With mean errors of ^1. 6 mas yr(-1) the accuracies of our proper motions approach those derived from Hipparcos and for a few of the stars in our program are better than the Hipparcos values. Comparing the positions of our radio stars with the Hipparcos catalog we find that the two frames are aligned to within formal errors of approximately 3 mas. This result confirms that the Hipparcos frame is inertial at the expected level.
DTIC
Radio Sources (Astronomy); Very Large Array (Vla); Position (Location); Astrometry; Stellar Motions

20030060684 Scientific Advisory Board (Air Force) Washington DC, Washington, DC, USA
Space Surveillance, Asteroids and Comets, and Space Debris, Volume 1, Space Surveillance
Naka, F. R.; Canavan, G. H.; Clinton, R. A.; Judd, O. P.; Pensa, A. F.; Jun. 1997; 68 pp.; In English; Original contains color illustrations
Report No.(s): AD-A412693; SAB-TR-96-04; No Copyright; Avail: CASI; A04, Hardcopy

This Study was produced by the Air Force Scientific Advisory Board. It was requested by the Commander Air Force Space Command and approved by the Secretary and Chief of Staff of the Air Force. It covers three topics, each of sufficient depth to be study of its own: Space Surveillance, Asteroid and Comet Impact Warning for Earth, and Space Debris. Space Surveillance is the unifying theme. Space Surveillance is a secondary mission to that of Missile Warning and has long been neglected. Almost all sensors were deployed for missile warning and used for Space Surveillance on a non-interference basis. Attempts to improve data processing, though expensive, were upgraded to the mainframe environment, keeping most old algorithms in place. Fortunately, improving the accuracy and timeliness of the sensors and data processing is now relatively inexpensive because most techniques are commercially available. Ultimately, Space Surveillance should be conducted from spaceborne sensors. They are discussed and recommended here.
DTIC
Data Processing; Space Surveillance (Ground Based)

20030061071 Space Telescope Science Inst., Baltimore, MD, USA
Global Properties of Local Star Forming Galaxies (ADP 2000)
Leitherer, Claus; March 17, 2003; 2 pp.; In English
Contract(s)/Grant(s): NAG5- 11023; STScI Proj. J0331; No Copyright; Avail: CASI; A01, Hardcopy

We performed an archival study of the Hopkins Ultraviolet Telescope (HUT) Astro-2 database. Nineteen spectra of star-forming regions and starburst galaxies were retrieved, reprocessed, and analyzed. The spectra cover the wavelength region 912- 1800 A, providing access to the domain of peak luminosity from a young stellar population. We created an atlas of galaxy spectra documenting the continuum and line properties with an emphasis on the relatively unexplored spectral region below 1200 A. The dust obscuration law was derived from a comparison of the HUT spectra with synthetic population models. The law is similar to the commonly adopted starburst reddening curve at longer wavelengths and approaches the Milky Way law near the Lyman break. A simple power-law parameterization is given, which allows users to express the reddening law in terms of the stellar or nebular color excess at ultraviolet or optical wavelengths. We studied the effect of time-dependent dust obscuration on synthetic ultraviolet line profiles of a young stellar population. If the youngest and most massive stars are more obscured than the older, less massive stars, the C IV 1550 and other stellar wind lines are significantly diluted with respect to a simple foreground screen model for the dust. We propose to use stellar wind lines as a probe of the dust-obscuration model instead of the previously employed nebular emission lines. Since purely stellar diagnostics are utilized, uncertain assumptions on the nebular properties are unnecessary. Photoionization models demonstrate that the C IV 1550 emission is typically dominated by stellar winds and nebular contamination is negligible. A first comparison with the galaxy sample observed with the Hopkins Ultraviolet Telescope favors a dust geometry affecting ionizing and nonionizing stars equally. We point out the

need for higher quality data for a more rigorous comparison. The Hubble Space Telescope is capable of obtaining such data in the future.
Author
Starburst Galaxies; Star Formation; Ultraviolet Astronomy; Ultraviolet Telescopes; Data Bases; Line Spectra

20030061158 National Space Science and Technology Center, Huntsville, AL, USA, NASA Marshall Space Flight Center, Huntsville, AL, USA
Characterization of the Crab Pulsar's Timing Noise
Scott, D. M.; Finger, M. H.; Wilson, C. A.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

We present a power spectral analysis of the Crab pulsar's timing noise, mainly using radio measurements from Jodrell Bank taken over the period 1982-1989, an interval bounded by sparse data sampling and a large glitch. The power spectral analysis is complicated by nonuniform data sampling and the presence of a steep red power spectrum that can distort power spectra measurement by causing severe power 'leakage'. We develop a simple windowing method for computing red noise power spectra of uniformly sampled data sets and test it on Monte Carlo generated sample realizations of red power-law noise. We generalize time-domain methods of generating power-law red noise with even integer spectral indices to the case of noninteger spectral indices. The Jodrell Bank pulse phase residuals are dense and smooth enough that an interpolation onto a uniform time series is possible. A windowed power spectrum is computed revealing a periodic or nearly periodic component with a period of 568 +/- 10 days and a l/f(exp 3) power-law noise component in pulse phase with a noise strength S(sub infinity)=(1.24 +/- 0.067) x 10(exp 16) cycles(exp 2)/sec(exp 2) over the analysis frequency range f=0.003- 0.1 cycles/day. This result deviates from past analyses which characterized the pulse phase timing residuals as either l/f(sub 4) power-law noise or a quasiperiodic process. The analysis was checked using the Deeter polynomial method of power spectrum estimation that was developed for the case of nonuniform sampling, but has lower spectral resolution. The timing noise is consistent with a torque noise spectrum rising with analysis frequency as f implying blue torque noise, a result not predicted by current models of pulsar timing noise. If the periodic or nearly periodic component is due to a binary companion, we find a mass function f(M) = (6.8 +/- 2.4) x 10(exp -16) solar mass and a companion mass, M(sub c) is greater than or equal to 3.2 solar mass assuming a Crab pulsar mass of 1.4 solar mass.
Author
Radio Astronomy; Power Spectra; Cepstral Analysis; Signal Distortion; Pulsars; Frequency Ranges; Monte Carlo Method; Noise Spectra

20030061175 NASA Marshall Space Flight Center, Huntsville, AL, USA
Preliminary Results from Recent Simultaneous Chandra/HST Observations of Jupiter Auroral Zones
Elsner, R.; Gladstone, R.; Waite, H.; Majeed, T.; Ford, P.; Grodent, D.; Bwardwaj, A.; Howell, R.; Cravens, T.; MacDowell, R., et al.; [2003]; 1 pp.; In English; 202nd Meeting of the American Astronomical Society, 25-29 May 2003, Nashville, TN, USA; Copyright; Avail: Other Sources; Abstract Only

Jupiter was observed by the Chandra X-ray Observatory in late February, 2003, for 144 ks, using both the ACIS-S and HRC-I imaging x-ray cameras. Five orbits of HST STIS observations of the planet's northern auroral zone were obtained during the ACIS-S observations. These data are providing a wealth of information about Jupiter's auroral activity, including the first x-ray spectra from the x-ray hot spots inside the auroral ovals. We will also discuss the approximately 45 minute quasi-periodicity in the auroral x-ray emission - which correlates well with simultaneous observations of radio bursts by the Ulysses spacecraft - and a possible phase relation between the emission from the northern and southern x-ray aurora.
Author
Auroral Zones; Jupiter (Planet); X Ray Astronomy; X Ray Spectra

20030061339 NASA Marshall Space Flight Center, Huntsville, AL, USA
Properties of Ultra-Luminous X-ray Sources in the Chandra Archive of Galaxies
Swartz, Douglas A.; Ghosh, Kajal K.; Tennant, Allyn F.; [2003]; 1 pp.; In English; American Astronomical Society Conference, 25-29 May 2003, Nashville, TN, USA; No Copyright; Avail: Other Sources; Abstract Only

We report the spatial, spectral, and temporal properties of Ultra-Luminous X-ray sources (ULXs) as obtained from the Chandra Advanced CCD Imaging Spectrometer archive of external galaxies. We show how these characteristics are used to help distinguish among proposed classes of ULXs (supernovae, intermediate-mass black holes, beamed sources, etc.) and to

help establish the origin and history of ULXs based on properties of their host galaxies.
Author
X Ray Sources; X Ray Astronomy; Spectrum Analysis

20030061416 NASA Marshall Space Flight Center, Huntsville, AL, USA
CME Prediction from Line-of-Sight Magnetogram
Falconer, D. A.; Moore, R. L.; Gary, G. A.; [2003]; 1 pp.; In English; Solar Physics Division/American Astronomical Society, 16-20 Jun. 2003, Laurel, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

We have previously shown for bipolar active regions that measures of active-region nonpotentiality from vector magnetograms are correlated with active-region CME productivity. We have now obtained a measure from line-of-sight magnetograms that is well correlated both with our measures of active-region nonpotentiality from vector magnetograms and with active-region CME productivity. The measure is the length of strong-gradient main neutral line (L(sub G)). This is the length of the bipolar region's main neutral line on which the potential transverse field is greater than 150G, and the gradient in the line-of-sight field is greater than 50G/Mm. From the sample of 17 MSFC magnetograms of 12 basically bipolar active regions used in our previous paper, we find that L(sub G) is strongly correlated with one of our vector-magnetogram measures of nonpotentiality, the length of strong-gradient main neutral line L(sub SS) (99.7\%). We also find that L(sub G) is as strongly correlated with CME productivity (99.7\%) as is L(sub SS). Being obtainable from line-of-sight magnetograms, L(sub G) makes the much larger data set of line-of-sight magnetograms (i.e. from SOHO/MDI and Kitt Peak) available for CME prediction study. This is especially important for evolutionary studies, with SOHO/MDI having no daylight, cloudy weather, or atmospheric seeing problems. This work was supported by funding from NSF's division of Atmospheric Sciences (Space Weather and Shine Programs) and by NASA's office of Space Science (Living with a Star program Solar and Heliospheric Physics Supporting Research and Technology program).
Author
Coronal Mass Ejection; Magnetic Signatures; Line Of Sight; Stellar Activity

20030061420 Massachusetts Inst. of Tech., Cambridge, MA, USA
Microfabricated X-Ray Optics Technology Development for the Constellation-X Mission
Schattenburg, Mark L.; July 2003; 3 pp.; In English
Contract(s)/Grant(s): NCC5-633
Report No.(s): MIT-OSP-6893098; No Copyright; Avail: CASI; A01, Hardcopy

During the period of this Cooperative Agreement, MIT developed advanced methods for applying silicon micro-stuctures for the precision assembly of foil x-ray optics in support of the Constellution-X Spectroscopy X-ray Telescope (SXT) development effort at Goddard Space Flight Center (GSFC). MIT developed improved methods for fabricating and characterizing the precision silicon micro-combs. MIT also developed and characterized assembly tools and several types of metrology tools in order to characterize and reduce the errors associated with precision assembly of foil optics. Results of this effort were published and presented to the scientific community and the GSFC SXT team.
Author
X Ray Telescopes; X Ray Optics; Microstructure; Nanofabrication

20030061422 NASA Marshall Space Flight Center, Huntsville, AL, USA
A Measure from Line-of-Sight Magnetograms for Prediction of Coronal Mass Ejections
Falconer, D. A.; Moore, R. L.; Gary, G. A.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

From a sample of 17 vector magnetograms of 12 bipolar active regions, we have recently found (1) that a measure of the overall nonpotentiality (the overall twist and shear in the magnetic field) of an active region is given by the strong-shear length L(sub SS), the length of the portion of the main neutral line on which the observed transverse fields is strong (greater than 150 G) and strongly sheared (shear angle greater than 45 deg), and (2) that L(sub SS) is well correlated with the CME productivity of the active regions during the +/- 2-day time window centered on the day of the magnetogram. In the present paper, from the same sample of 17 vector magnetograms, we show that there is a viable proxy for L(sub SS) that can be measured from a line-of-sight magnetogram. This proxy is the strong-gradient length L(sub SG), the length of the portion of the main neutral line on which the potential transverse field is strong (greater than 150 G) and the gradient of the line-of-sight field is sufficiently steep (greater than or approximately 50 G/Mm). In our sample of active regions, L(sub SG) is statistically significantly correlated with L(sub SS) (correlation confidence level greater than 95\%), and L(sub SG) is as strongly correlated with active-region CME productivity as is L(sub SS)(correlation confidence level approximately 99.7\%). Because

L(sub SG) can be measured from line-of-sight magnetograms obtained from conventional magnetographs, such as the magnetograph mode of the Michelson Doppler Imager (MDI) on board the Solar and Heliospheric Observatory (SOHO), it is a dependable substitute for L(sub SS) for use in operational CME forecasting. In addition, via measurement of L(sub SG), the years-long, nearly continuous sequence of 1.5-hour-cadence full-disk line-of-sight magnetograms from MDI can be used to track the growth and decay of the large-scale nonpotentiality in active regions and to examine the role of this evolution in active-region CME productivity.
Author
Coronal Mass Ejection; Line Of Sight; Magnetic Signatures; Predictions

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ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

20030060402 Nevada Univ., Las Vegas, NV, USA
Laboratory Studies of Thermal Energy Charge Transfer of Multiply Charged Ions in Astrophysical Plasmas
Kwong, Victor H. S.; [2003]; 5 pp.; In English
Contract(s)/Grant(s): NAG5-11990; No Copyright; Avail: CASI; A01, Hardcopy

The laser ablation/ion storage facility at the UNLV Physics Department has been dedicated to the study of atomic and molecular processes in low temperature plasmas. Our program focuses on the charge transfer (electron capture) of multiply charged ions and neutrals important in astrophysics. The electron transfer reactions with atoms and molecules is crucial to the ionization condition of neutral rich photoionized plasmas. With the successful deployment of the Far Ultraviolet Spectroscopic Explorer (FUSE) and the Chandra X-ray Observatory by NASA high resolution VUV and X-ray emission spectra fiom various astrophysical objects have been collected. These spectra will be analyzed to determine the source of the emission and the chemical and physical environment of the source. The proper interpretation of these spectra will require complete knowledge of all the atomic processes in these plasmas. In a neutral rich environment, charge transfer can be the dominant process. The rate coefficients need to be known accurately. We have also extended our charge transfer measurements to KeV region with a pulsed ion beam. The inclusion of this facility into our current program provides flexibility in extending the measurement to higher energies (KeV) if needed. This flexibility enables us to address issues of immediate interest to the astrophysical community as new observations are made by high resolution space based observatories.
Author
Research Facilities; Laboratories; Astrophysics; Electron Capture; Electron Transfer; Charge Transfer; Cold Plasmas; X Ray Astronomy; Ultraviolet Astronomy

20030060413 California Univ., Lawrence Berkeley National Lab., Berkeley, CA, USA
Quantum Cosmology Based on Discrete Feynman Paths
Chew, G. F.; Oct. 10, 2002; 19 pp.; In English
Report No.(s): DE2003-806128; No Copyright; Avail: Department of Energy Information Bridge

Although the rules for interpreting local quantum theory imply discretization of process, Lorentz covariance is usually regarded as precluding time quantization. Nevertheless a time-discretized quantum representation of redshifting spatially-homogeneous universe may be based on discrete-step Feynman paths carrying causal Lorentz-invariant action--paths that not only propagate the wave function but provide a phenomenologically-promising elementary-particle Hilbert-space basis. In a model under development, local path steps are at Planck scale while, at a much larger 'wave-function scale', global steps separate successive wave-functions. Wave-function spacetime is but a tiny fraction of path spacetime. Electromagnetic and gravitational actions are 'at a distance' in Wheeler-Feynman sense while strong (color) and weak (isospin) actions, as well as action of particle motion, are 'local' in a sense paralleling the action of local field theory. 'Nonmaterial' path segments and 'trivial events' collaborate to define energy and gravity.
NTIS
Cosmology; Feynman Diagrams; Quantum Theory; Space-Time Functions; Wave Functions; Discretization (Mathematics)

20030060650 NASA Marshall Space Flight Center, Huntsville, AL, USA
The Nonlinear Coupling of Alfven and Lower Hybrid Waves in Space Plasma
Khazanov, G. V.; Singh, N.; Krivorutsky, E.; [2003]; 1 pp.; In English; The Fifth International Meeting on Nonlinear Waves and Chaos in Space Plasmas, 2-7 Mar. 2003, Murnbai, India; No Copyright; Avail: Other Sources; Abstract Only

Space plasmas support a wide variety of waves, and wave-particle interactions as well as wave-wave interactions which are of crucial importance to magnetospheric and ionospheric plasma behavior. The excitation of lower hybrid waves (LHWs), in particular, is a widely discussed mechanism of interaction between plasma species in space and is one of the unresolved questions of magnetospheric multi-ion plasmas. It is demonstrated that large-amplitude Alfven waves may generate LHWs in the auroral zone and ring current region and in some cases (particularly in the inner magnetosphere) this serves as the Alfven wave saturation mechanism. We present several examples of observational data which illustrate that the proposed mechanism is a plausible candidate to explain certain classes of LHW generation events in the ionosphere and magnetosphere and demonstrate electron and ion energization involving these processes. Furthermore, we will present results from particle-in-cell simulations showing the generation of particle drifts in response to an Alfven wave, resulting in excitation of waves and ion heating in a multi- ion plasma.
Author
Space Plasmas; Shock Wave Interaction; Wave-Particle Interactions; Magnetohydrodynamic Waves; Nonlinearity; Magnetosphere-Ionosphere Coupling

20030060652 Carnegie Institution of Washington, Washington, DC, USA
Mixing and Transport in the Solar Nebula
Boss, Alan P.; [2003]; 3 pp.; In English
Contract(s)/Grant(s): NAG5-10547; No Copyright; Avail: CASI; A01, Hardcopy

Boss & Vanhala (2000, 2001) prepared reviews of triggered collapse and injection models, using Prudence Foster's finite differences code at very high spatial resolution (440 x 1440 cells) to demonstrate the convergence of the R-T fingers in triggered injection models. A two dimensional hydrodynamical calculation with unprecedentedly high spatial resolution (960 x 2880 zones, or almost 3 million grid points) demonstrated that it suitable shock front can both trigger the collapse of an otherwise stable presolar cloud, and inject shock front particles into the collapsing cloud through the formation of what become Rayleigh-Taylor fingers of compressed fluid layers falling into the gravitational potential well of the growing protostar. These calculations suggest that heterogeneity derived from these R-T fingers will persist down to the scale of their injection onto the surface of the solar nebula. Haghighipour developed a numerical code capable of calculating the orbital evolution of dust grains of varied sizes in a gaseous nebula, subject to Epstein and Stokes drag as well as the self-gravity of the disk. In collaboration with the PI and George W. Wetherill, Haghighipour has been involved in development of a new idea on the possibility of rapid formation of ice giant planets via the disk instability mechanism. Haghighipour studied the stability of a five-body system consisting of the Sun and four protoplanets by numerically integrating their equations of motions. Using Levison and Duncan s SWIFT integrator, Haghighipour showed that, depending on the orbital parameters of the bodies, such a system can be stable for 0.1-10 Myr. Time periods of 1 Myr or more are long enough to be consistent with the time scale proposed for the formation of giant planets by the disk instability mechanism and the photoevaporation of the gaseous envelopes of the outermost protoplanets by a nearby OB star, resulting in the formation of ice giant planets. The PI has used his three dimensional models of marginally gravitationally unstable disks to study the preservation of isotopic heterogeneity in evolving protoplanetary disks. Such heterogeneity might arise from the infall onto the disk s surface of solids processed in the X-wind region of the disk, or derived from stellar nucleosynthesis and injected by R-T fingers. The technique used consists of solving a color equation, identical to the gas continuity equation, which follows the time evolution in three space dimensions of an arbitrarily placed initial color field, i.e., a dye inserted the disk. The models show that significant concentrations of color could persist for time periods of about a thousand years or more, even in the most dynamically active region of such a disk. Such a time period might be long enough for solids to coagulate and grow to significant sizes while retaining the isotopic signature of their birth region in the nebula.
Author
A Stars; Computational Grids; Nebulae; Nuclear Fusion; Planetary Evolution; Spatial Resolution; Three Dimensional Models; Evolution (Development)

20030061075 Charleston Coll., Charleston, SC, USA
A Search for Early High-Energy Afterglows in BATSE Gamma-Ray Bursts
Giblin, Timothy W.; June 30, 2003; 12 pp.; In English
Contract(s)/Grant(s): NAG5-11017; No Copyright; Avail: CASI; A03, Hardcopy

The scope of this project was to perform a detailed search for the early high-energy afterglow component of gamma-ray bursts (GRBs) in the BATSE GRB data archive. GRBs are believed to be the product of shock waves generated in a relativistic outflow from the demise of extremely massive stars and/or binary neutron star mergers. The outflow undeniably encounters the ambient medium of the progenitor object and another shock wave is set up. A forward shock propagates into the medium

and a reverse shock propagates through the ejecta. This 'external' shock dissipates the kinetic energy of the ejecta in the form of radiation via synchrotron losses and slows the outflow eventually to a non-relativistic state. Radiation from the forward external shock is therefore expected to be long-lived, lasting days, weeks, and even months. This radiation is referred to as the 'afterglow'.
Author
Gamma Ray Bursts; Afterglows; Gamma Ray Astronomy

20030061172 NASA Marshall Space Flight Center, Huntsville, AL, USA
Particle Acceleration in Relativistic Jets due to Weibel Instability
Nishikawa, K.; Hardee, P. E.; Richardson, G. A.; Preece, R. D.; Sol, H.; Fishman, G. J.; [2003]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Shock acceleration is an ubiquitous phenomenon in astrophysical plasmas. Plasma waves and their associated instabilities (e.g., the Buneman instability, two-streaming instability, and the Weibel instability) created in the shocks are responsible for particle (electron, positron, and ion) acceleration. Using a 3-D relativistic electromagnetic particle (REMP) code, we have investigated particle acceleration associated with a relativistic jet front propagating through an ambient plasma with and without initial magnetic fields. We find only small differences in the results between no ambient and weak ambient magnetic fields. Simulations show that the Weibel instability created in the collisionless shock front accelerates particles perpendicular and parallel to the jet propagation direction. The simulation results show that this instability is responsible for generating and amplifying highly nonuniform, small-scale magnetic fields, which contribute to the electron s transverse deflection behind the jet head. The jitter radiation (Medvedev 2000) from deflected electrons has different properties than synchrotron radiation which is calculated in a uniform magnetic field. This jitter radiation may be important to understanding the complex time evolution and/or spectral structure in gamma-ray bursts, relativistic jets, and supernova remnants.
Author
Particle Acceleration; Relativistic Particles; Weibel Instability; Plasma Waves; Astrophysics; Electromagnetic Fields; Shock Fronts

20030061228 NASA Marshall Space Flight Center, Huntsville, AL, USA
Chandra X-Ray Observatory Observations of the Globular Cluster M28 and its Millisecond Pulsar PSR B1821-24
Becker, Werner; Swartz, Douglas A.; Pavlov, George G.; Elsner, Ronald F.; Grindlay, Jonathan; Mignani, Roberto; Tennant, Allyn F.; Backer, Don; Weisskopf, Martin C.; [2003]; 1 pp.; In English; Copyright; Avail: Other Sources

We report here the results of the first Chandra X-Ray Observatory observations of the globular cluster M28 (NGC 6626). We detect 46 X-ray sources of which 12 lie within one core radius of the center. We show that the apparently extended X-ray core emission seen with the ROSAT HRI is due to the superposition of multiple discrete sources for which we determine the X-ray luminosity function down to a limit of about 6 x 10(exp 30) erg/s. We measure the radial distribution of the X-ray sources and fit it to a King profile finding a core radius of r(sub c,x) approx. 11 sec. We obtain the best-fit mass of the X-ray sources to be M(sub x) approx. 1.9 solar masses. We measure for the first time the unconfused phase-averaged X-ray spectrum of the 3.05-ms pulsar B1821-24 and find it best described by a power law with photon-index Gamma approx. equal to 1.2. We find marginal evidence of an emission line centered at 3.3 kev in the pulsar spectrum, which could be interpreted as cyclotron emission from a corona above the pulsar's polar cap if the the magnetic field is strongly different from a centered dipole. The unabsorbed pulsar flux in the 0.5-8.0 keV band is approx. 3.5 x 10(exp -13) ergs/s/sq cm. We present spectral analyses of the 5 brightest unidentified sources. Based on the spectral parameters of the brightest of these sources, we suggest that it is a transiently accreting neutron star in a low-mass X-ray binary, in quiescence. Fitting its spectrum with a hydrogen neutron star atmosphere model yields the effective temperature T(sup infinity)(sub eff) = 90(sup +30)(sub -10) eV and the radius R(sup infinity)(sub NS) = 14.5(sup +6.9)(sub -3.8) km. In addition to the resolved sources, we detect fainter, unresolved X-ray emission from the central core. Using the Chandra-derived positions, we also present a preliminary report on the result of searching archival Hubble Space Telescope data for possible optical counterparts.
Author
X Ray Astrophysics Facility; X Ray Astronomy; Globular Clusters; Pulsars; X Ray Sources

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LUNAR AND PLANETARY SCIENCE AND EXPLORATION

Includes planetology; selenology; meteorites; comets; and manned and unmanned planetary and lunar flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance*.

20030060565 Orbital Technologies Corp., USA
Carbon-Based Reduction of Lunar Regolith (CRLR)
Rice, E. E.; Gustafson, R. J.; White, B. W.; Jordan, J.; 2002 Microgravity Materials Science Conference; February 2003, pp. 493; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

ORBITEC has developed a new high-temperature processing technique to produce oxygen and metals from lunar regolith via carbonaceous high-temperature reduction. A CO2 laser is used to locally heat and process the lunar simulant. The surrounding simulant effectively insulates the container from the high processing temperatures. This technique overcomes problematic issues inherent in traditional high-temperature processing methods that employ crucible-type containment vessels and hot-walled (i.e., resistance or inductive) furnaces. Crucible containment structures either crack from thermal and mechanical stress and/or react with the molten reaction mix, making it very unlikely that such a material could survive the repeated high-temperature thermal cycling in an economical LOX plant on the Moon. The direct heating method will allow extremely high processing temperatures (>2000 C) and eliminate the difficult requirement of developing a containment vessel that withstands these temperatures, is impervious to prolonged chemical attack, and is capable of thermal cycling. A ground-based experimental system was designed, built, and tested. The experimental system includes an integrated reaction chamber, CO2 laser equipment, laser beam rastering system, residual gas analyzer, and the control computers. Software was been developed to operate the mass spectrometer, control the laser power, and perform data acquisition on a desktop computer. A second computer is used to control the laser beam rastering system. An internal circulation fan was integrated to keep the zinc selenide laser window in the reaction chamber clean during laser processing. Heat transfer models were developed to predict the temperature gradients in the lunar simulant during laser processing. Thermocouples were also installed in the simulant to directly measure the surface temperature gradients during laser processing. Carbothermal reduction of the lunar simulant was demonstrated using two different methods. In the first case, carbon black was mixed directly in the lunar simulant. This mixture was placed inside the reaction chamber and laser heated in a pure argon gas environment. Analysis of the product gas showed the formation of carbon monoxide, indicating carbothermal reduction. The second method placed simulant inside the reaction chamber in an argon and methane gas environment. Analysis of the product gas showed the formation of carbon monoxide gas. Hydrogen reduction of the lunar simulant was also demonstrated with the direct heating approach. The experimental results were used to develop a preliminary design of a lunar flight experiment and a pilot production plant.
Author
Regolith; Lunar Rocks; Oxygen Production; Reduction (Chemistry); Laser Heating; Carbon

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SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots. For related information see *93 Space Radiation*.

20030061137 NASA Marshall Space Flight Center, Huntsville, AL, USA
Beyond Solar-B: MTRAP, the Magnetic Transition Region Probe
Davis, John M.; Moore, Ronald L.; Hathaway, David H.; [2003]; 2 pp.; In English; Solar Physics Division/American Astronomical Society Meeting, 16-19 Jun. 2003, Laurel, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

The next generation of solar missions will reveal and measure fine-scale solar magnetic fields and their effects in the solar atmosphere at heights, small scales, sensitivities, and fields of view well beyond the reach of Solar-B. The necessity for, and potential of, such observations for understanding solar magnetic fields, their generation in and below the photosphere, and their control of the solar atmosphere and heliosphere, were the focus of a science definition workshop, 'High-Resolution Solar Magnetography from Space: Beyond Solar-B,' held in Huntsville Alabama in April 2001. Forty internationally prominent scientists active in solar research involving fine-scale solar magnetism participated in this Workshop and reached consensus that the key science objective to be pursued beyond Solar-B is a physical understanding of the fine-scale magnetic structure and activity in the magnetic transition region, defined as the region between the photosphere and corona where neither the plasma nor the magnetic field strongly dominates the other. The observational objective requires high cadence (less than 10s)

vector magnetic field maps, and spatially resolved spectra from the IR, visible, vacuum UV, to the EUV at high resolution (less than 50km) over a large FOV (approximately 140,000 km). A polarimetric resolution of one part in ten thousand is required to measure transverse magnetic fields of less than 30G. The latest SEC Roadmap includes a mission identified as MTRAP to meet these requirements. Enabling technology development requirements include large, lightweight, reflecting optics, large format sensors (16K x 16K pixels) with high QE at 150 nm, and extendable spacecraft structures. The Science Organizing Committee of the Beyond Solar-B Workshop recommends that: (1) Science and Technology Definition Teams should be established in FY04 to finalize the science requirements and to define technology development efforts needed to ensure the practicality of MTRAP's observational goals; (2) The necessary technology development funding should be included in Code S budgets for FY06 and beyond to prepare MTRAP for a new start no later than the nominal end of the Solar-B mission, around 2010.
Author
Plasmas (Physics); Solar Physics; Mission Planning; Solar Magnetic Field; Interplanetary Magnetic Fields; Heliosphere; Magnetic Properties

20030061289 NASA Marshall Space Flight Center, Huntsville, AL, USA
Observed Helicity of Active Regions in Solar Cycle 21
Hagyard, M. J.; Pevtsov, A. A.; Blehm, Z.; Smith, J. E.; [2003]; 1 pp.; In English; Johns Hopkins University Applied Physics Laboratory Conference, 18 Jun. 2003, Columbia, MD, USA; Copyright; Avail: Other Sources; Abstract Only

We report the results of a study of magnetic helicity in solar active regions during solar cycles 21 and 22 from observations with the Marshall Space Flight Center's solar vector magnetograph. Using the force-free parameter a as the proxy for helicity, we calculated an average value of a for each of 91 active regions from a total of 683 vector magnetograms that were obtained during the period March 1980 to July 1993. The signs of these average values of a were correlated with the latitude of the active regions to test the hemispherical rule of helicity that has been proposed for solar magnetic fields: negative helicity predominant in northern latitudes, positive in the southern ones. We have found that of the 65 regions that were observed in cycle 21,49\% obey the hemispherical rule and 51\% do not. On the other hand, for the 26 regions in cycle 22,65\% do exhibit this correlation. In addition, our results seem to support the findings of Hagino and Sakurai (2002) which indicate evidence for a time variability in the hemispheric rule.
Author
Magnetic Signatures; Solar Cycles; Magnetometers; Cosmic Rays

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SPACE RADIATION

Includes cosmic radiation; and inner and outer Earth radiation belts. For biological effects of radiation on plants and animals see *51 Life Sciences*; on human beings see 52 Aerospace Medicine. For theory see *73 Nuclear Physics*.

20030060568 NASA Johnson Space Center, Houston, TX, USA
Secondary Neutron Production from Space Radiation Interactions: Advances in Model and Experimental Data Base Development
Heilbronn, Lawrence H.; Townsend, Lawrence W.; Braley, G. Scott; Iwata, Yoshiyuki; Iwase, Hiroshi; Nakamura, Takashi; Ronningen, Reginald M.; Cucinotta, Francis A.; 2002 Microgravity Materials Science Conference; February 2003, pp. 282; In English; See also 20030060494; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

For humans engaged in long-duration missions in deep space or near-Earth orbit, the risk from exposure to galactic and solar cosmic rays is an important factor in the design of spacecraft, spacesuits, and planetary bases. As cosmic rays are transported through shielding materials and human tissue components, a secondary radiation field is produced. Neutrons are an important component of that secondary field, especially in thickly-shielded environments. Calculations predict that 50\% of the dose-equivalent in a lunar or Martian base comes from neutrons, and a recent workshop held at the Johnson Space Center concluded that as much as 30\% of the dose in the International Space Station may come from secondary neutrons. Accelerator facilities provide a means for measuring the effectiveness of various materials in their ability to limit neutron production, using beams and energies that are present in cosmic radiation. The nearly limitless range of beams, energies, and target materials that are present in space, however, means that accelerator-based experiments will not provide a complete database of cross sections and thick-target yields that are necessary to plan and design long-duration missions. As such, accurate nuclear models of neutron production are needed, as well as data sets that can be used to compare with, and verify,

the predictions from such models. Improvements in a model of secondary neutron production from heavy-ion interactions are presented here, along with the results from recent accelerator-based measurements of neutron-production cross sections. An analytical knockout-ablation model capable of predicting neutron production from high-energy hadron-hadron interactions (both nucleon-nucleus and nucleus-nucleus collisions) has been previously developed. In the knockout stage, the collision between two nuclei result in the emission of one or more nucleons from the projectile and/or target. The resulting projectile and target remnants, referred to as prefragments, then decay by the emission of nucleons, composites, and gamma rays. Recent improvements to the model have incorporated coalescence effects, which effectively tie up single nucleons in the formation of composites during final-state interactions. Comparison of the improved model s predictions with neutron production data near 0 deg in the CA-40+ H reaction at 357 and 565 MeV/nucleon show marked improvement.
Author
Cosmic Rays; Extraterrestrial Radiation; Neutron Sources; Mathematical Models; Particle Interactions

20030060588 NASA Langley Research Center, Hampton, VA, USA
Measurement of Charged Particle Interactions in Spacecraft and Planetary Habitat Shielding Materials
Zeitlin, Cary J.; Heilbronn, Lawrence H.; Miller, Jack; Wilson, John W.; Singleterry, Robert C., Jr.; 2002 Microgravity Materials Science Conference; February 2003, pp. 708-712; In English; See also 20030060494; Original contains color and black and white illustrations; No Copyright; Avail: CASI; A01, Hardcopy

Accurate models of health risks to astronauts on long-duration missions outside the geomagnetosphere will require a full understanding of the radiation environment inside a spacecraft or planetary habitat. This in turn requires detailed knowledge of the flux of incident particles and their propagation through matter, including the nuclear interactions of heavy ions that are a part of the Galactic Cosmic Radiation (GCR). The most important ions are likely to be iron, silicon, oxygen, and carbon. Transport of heavy ions through complex shielding materials including self-shielding of tissue modifies the radiation field at points of interest (e.g., at the blood-forming organs). The incident flux is changed by two types of interactions: (1) ionization energy loss, which results in reduced particle velocity and higher LET (Linear Energy Transfer); and (2) nuclear interactions that fragment the incident nuclei into less massive ions. Ionization energy loss is well understood, nuclear interactions less so. Thus studies of nuclear fragmentation at GCR-like energies are needed to fill the large gaps that currently exist in the database. These can be done at only a few accelerator facilities where appropriate beams are available. Here we report results from experiments performed at the Brookhaven National Laboratory s Alternating Gradient Synchrotron (AGS) and the Heavy Ion Medical Accelerator in Chiba, Japan (HIMAC). Recent efforts have focused on extracting charge-changing and fragment production cross sections from silicon beams at 400, 600, and 1200 MeV/nucleon. Some energy dependence is observed in the fragment production cross sections, and as in other data sets the production of fragments with even charge numbers is enhanced relative to those with odd charge numbers. These data are compared to the NASA-LaRC model NUCFRG2. The charge-changing cross section data are compared to recent calculations using an improved model due to Tripathi, which accurately predicts the observed (slight) energy dependence. An additional set of data will be presented from an analysis of shielding material performance in the 1 GeV/nucleon iron beam at the AGS. A wide variety of candidate materials for spacecraft construction, as well as elemental targets, have been placed in this beam and their effects on transmitted dose and dose equivalent measured. The results support a prediction by J. Wilson et al. that hydrogen-loaded materials give the greatest dose reduction per unit mass.
Author
Cosmic Rays; Galactic Radiation; Charged Particles; Energy Dissipation; Heavy Ions; Particle Interactions

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GENERAL

Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs such as Apollo, Gemini, and Mercury spacecraft, Earth Resources Technology Satellite (ERTS), and Skylab; NASA appropriations hearings.

20030059513 NASA Langley Research Center, Hampton, VA, USA
Concept to Reality: Contributions of the Langley Research Center to US Civil Aircraft of the 1990s
Chambers, Joseph R.; [2003]; 306 pp.; In English; Original contains color illustrations
Report No.(s): NASA/SP-2003-4529; NAS 1.21:4529; LC-2002026352; Copyright; Avail: CASI; A14, Hardcopy

This document is intended to be a companion to NASA SP-2000-4519, 'Partners in Freedom: Contributions of the Langley Research Center to U.S. Military Aircraft of the 1990s'. Material included in the combined set of volumes provides

informative and significant examples of the impact of Langley's research on U.S. civil and military aircraft of the 1990s. This volume, 'Concept to Reality: Contributions of the NASA Langley Research Center to U.S. Civil Aircraft of the 1990s', highlights significant Langley contributions to safety, cruise performance, takeoff and landing capabilities, structural integrity, crashworthiness, flight deck technologies, pilot-vehicle interfaces, flight characteristics, stall and spin behavior, computational design methods, and other challenging technical areas for civil aviation. The contents of this volume include descriptions of some of the more important applications of Langley research to current civil fixed-wing aircraft (rotary-wing aircraft are not included), including commercial airliners, business aircraft, and small personal-owner aircraft. In addition to discussions of specific aircraft applications, the document also covers contributions of Langley research to the operation of civil aircraft, which includes operating problems. This document is organized according to disciplinary technologies, for example, aerodynamics, structures, materials, and flight systems. Within each discussion, examples are cited where industry applied Langley technologies to specific aircraft that were in operational service during the 1990s and the early years of the new millennium. This document is intended to serve as a key reference for national policy makers, internal NASA policy makers, Congressional committees, the media, and the general public. Therefore, it has been written for a broad general audience and does not presume any significant technical expertise. An extensive bibliography is provided for technical specialists and others who desire a more indepth discussion of the contributions.

Derived from text

NASA Programs; Research And Development; Civil Aviation; Histories; Aircraft Design; Aircraft Safety; Flight Management Systems

20030060675 NASA Glenn Research Center, Cleveland, OH, USA

Glenn's Strategic Partnerships With HBCUs and OMUs

Kankam, M. David; May 2003; 34 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 22-332-41-00-01

Report No.(s): NASA/TM-2003-212003; E-13689; NAS 1.15:212003; No Copyright; Avail: CASI; A03, Hardcopy

NASA senior management has identified the need to develop a strategy for increased contracting with the historically black colleges and universities (HBCUs) and other minority universities (OMUs). The benefits to the institutions, by partnering with NASA, include developing their industrial base via NASA-industry partnerships, strong competitive advantage in technology-based research opportunities, and improved research capabilities. NASA gains increased contributed value to the Agency missions and programs as well as potential future recruits from technology-trained students who also constitute a pool for the nation s workforce. This report documents synergistic links between Glenn Research Center research and technology programs and faculty expertise at HBCUs and OMUs. The links are derived, based on Glenn technologies in the various directorates, program offices, and project offices. Such links readily identify universities with faculty members who are knowledgeable or have backgrounds in the listed technologies for possible collaboration. Recommendations are made to use the links as opportunities for Glenn and NASA, as well as industry collaborators, to cultivate stronger partnerships with the universities. It is concluded that Glenn and its partners and collaborators can expect to mutually benefit from leveraging NASA s cutting-edge and challenging research and technologies; industry's high technology development, research and development facilities, system design capabilities and market awareness; and academia s expertise in basic research and relatively low overhead cost. Reduced cost, accelerated technology development, technology transfer, and infrastructure development constitute some of the derived benefits.

Author

NASA Programs; Research And Development; Minorities; University Program

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